



AGRICULTURAL RESEARCH INSTITUTE
PUSA

THE ANNALS
AND
MAGAZINE OF NATURAL HISTORY,

INCLUDING
ZOOLOGY, BOTANY, AND GEOLOGY.

(BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH LONDON AND
CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY'.)

CONDUCTED BY
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VOL. I.—FOURTH SERIES.

LONDON:

PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS.

SOLD BY LONGMANS, GREEN, READER, AND DYER; SIMPKIN, MARSHALL, AND CO.;
KENT AND CO.; BAILLIÈRE, REGENT STREET, AND PARIS:
MACLACHLAN AND STEWART, EDINBURGH:
HODGES AND SMITH, DUBLIN: AND ASNER, BERLIN.

1868.

"Omnes res create sunt divinæ sapientiæ et potentiæ testes, divitiis felicitatis humanæ:—ex harum usu *bonitas* Creatoris; ex pulchritudine *sapientia* Domini; ex œconomiâ in conservatione, proportione, *renovatione*, *potentia* majestatis elucet. *Earum* itaque indagatio ab hominibus sibi relictis semper æstimata; à verò eruditis et sapientibus semper exulta; malè doctis et barbaris semper inimica fuit."—LINNÆUS.

"Quel que soit le principe de la vie animale, il ne faut qu'ouvrir les yeux pour voir qu'elle est le chef-d'œuvre de la Toute-puissance, et le but auquel se rapportent toutes ses opérations."—BRÜCKNER, *Théorie du Système Animal*, Leyden, 1767.

. The ~~g~~ivian powers
 Obey our summons; from their deepest dells
 The Dryads come, and throw their garlands wild
 And odorous branches at our feet; the Nymphs
 That press with nimble step the mountain-thyme
 And purple heath-flower come not empty-handed,
 But scatter round ten thousand forms minute
 Of velvet moss or lichen, torn from rock
 Or rifted oak or cavern deep: the Naiads too
 Quit their loved native stream, from whose smooth face
 They crop the lily, and each sedge and rush
 That drinks the rippling tide: the frozen poles,
 Where peril waits the bold adventurer's tread,
 The burning sands of Borneo and Cayenne,
 All, all to us unlock their secret stores
 And pay their cheerful tribute.

J. TAYLOR, *Norwich*, 1818.



PREFACE TO THE FOURTH SERIES.

IN commencing the Fourth Series of the 'Annals and Magazine of Natural History' the Editors must express their gratitude to those by whose assistance they have been enabled already to complete Sixty volumes of this Periodical. Their thanks are indeed due in an especial manner to those Contributors whose papers give their chief value to its pages, and scarcely less to that numerous body of Subscribers who, by furnishing the means, are indirectly instrumental in the publication of these important works. The commencement of a new series affords an opportunity for intending subscribers to commence taking the 'Annals;' and the Editors hope that they may once more find in an increased circulation a proof that their efforts to maintain this Journal as a valuable Natural-History Publication have met with a favourable appreciation on the part of their readers.

Some slight changes which have already taken place in the contents of the 'Annals' require to be briefly alluded to. The regularity in the publication of their 'Proceedings' which has now been attained by the Zoological and Linnean Societies, and the consequent increase in the number of the papers laid before those Societies, rendered the publication of their Proceedings in this Journal one of very questionable advantage; for whilst their extension made it necessary that a very considerable portion of the papers read should be omitted, their early publication by the Societies themselves placed them on the footing of regular periodicals. For these reasons their Proceedings have lately and will henceforward be omitted from our pages; but abstracts will still be given of papers connected with natural history read before the Royal Society, and of many of those communicated to provincial Societies and Field Clubs, which otherwise are not so likely to come to the knowledge of many of our readers.

PREFACE.

The space thus gained may be advantageously filled with translations or abstracts of important memoirs published in foreign languages, and especially in Swedish and Danish periodicals, the contents of which, both from their rarity in this country and from the language in which they are written, are in general peculiarly inaccessible, while they are frequently of the greatest importance, to English naturalists. These conditions the Editors will use their best endeavours to fulfil; and they hope to succeed in sustaining the high character which this Journal has hitherto borne both in this country and abroad.

In this department, Mr. WILLIAM S. DALLAS, to whom for many years past the Editors have been indebted for valuable assistance, and whom they have great pleasure in announcing as a colleague, will continue his most efficient cooperation.

In concluding this preface the Editors have to advert with regret to some of the losses which this Journal has sustained by the death of its editors and valued contributors. Among the former, Professor HENFREY, whose name first appeared on the titlepage at the commencement of the third series, was removed from his active participation in the management of the Journal in less than two years; whilst Mr. SELBY, whose death occurred in the spring of last year, was first in the order of seniority of the editors, and the survivor of those who transferred their services from the 'Magazine of Zoology and Botany' when that journal was amalgamated with the 'Annals.' Mr. RICHARD TAYLOR also, the founder of this Journal, has been lost to us since the commencement of the Third Series. Among the contributors whose loss they have to deplore, the Editors may mention Mr. JOSHUA ALDER, of Newcastle, Dr. S. P. WOODWARD, of the British Museum, Mr. HYNDMAN, of Belfast, Professor HARVEY, the Rev. HAMLET CLARK, and that veteran naturalist, Mr. Wm. BEAN, of Scarborough.

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THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

"..... per litora spargite muscum,
 Naiades, et circum vitreos considite fontes:
 Pollice virgineo teneros hinc carpite flores:
 Floribus et pictum, divæ, replete canistrum.
 At vos, o Nymphæ Craterides, ite sub undas;
 Itæ, recurvato variata corallia trunco
 Vellite muscosis e rupibus, et mihi conchas
 Ferte, Dædæ pelagi, et pingui conchylio succo."
N. Parthenii Gianettasii Ecl. 1

No. 1. JANUARY 1868.

I.—*On the Structure of the Mouth in Sucking Crustacea.*
 By Prof. J. C. SCHIÖDTE*.

[Plate I.]

Part I. Cymothoæ.

1. The peculiar arrangement of the mouth in sucking Condyllopoda being the result of a more or less complete fusion and metamorphosis of the organs that compose the mouth in those which bite their food, we may regard the interpretation of the elements of the sucking-apparatus as affording the severest test of our knowledge of the principles which govern the structure of the mouth in Articulata generally. The demands which this difficult task makes upon our knowledge are so great that, in undertaking it, one cannot be long before discovering how little is gained in physiology, morphology, or natural systematic arrangement by even a very accurate knowledge of the structure of the various organs of the mouth in masticating Condyllopoda alone. An analysis of these organs, which aims at nothing more than such a knowledge, may supply material for artificial classification; but a truly scientific solution of the problem before us requires more, viz., on the one hand, a true estimate of the mode of coopera-

* Translated from 'Naturhistorisk Tidsskrift,' series 8. vol. iv. Copenhagen, 1866, with two plates, from which the outlines on Pl. I. are copied.

tion of the organs of the mouth in masticating Condylapoda, founded on careful consideration of their anatomic connexion with one another, and, on the other hand, a definition of the morphological equivalents of all the different parts which shall prove its own correctness by its self-consistency. With less preparation than this it would be useless to attempt an interpretation of the structure of the mouth in sucking Condylapoda.

It is one of the imperishable merits of Savigny that he has solved this problem in all essential points with regard to Insects; but with regard to Crustacea almost everything still remains to be done. In this class the investigation becomes complicated by the circumstance that the body is more or less united with the head, so that a varying number of its foremost pairs of limbs may be assimilated to the organs of the mouth in point of form and use. It will therefore be advantageous to begin our investigation with the order of Isopoda. On the one hand, this order occupies one of the highest steps to which the class of Crustacea upon the whole attains in the scale of development of the articulate type, whereby the comparison with the mouth of insects is much facilitated; whilst, on the other hand, it descends so low as to contain numerous parasitic species, and, therefore, is more likely than any other order to supply the key for the interpretation of the mouth in sucking Copepoda. How far this latter expectation will prove true cannot be shown more explicitly in this first paper; but the initiated will no doubt at once discern the application of the present analysis to lower forms.

2. Although it is sufficiently well known that at least some Cymothœ live upon liquid food, and although Rondelet, more than three centuries ago, has said, concerning one of these parasites, that it sucks like a leech*, the question of the structure of their sucking-apparatus is nevertheless, in a scientific point of view, entirely virgin soil. It is true that Bosc believed that he observed in a *Cymothoa* a retractile sucker with a pair of small palpi†; but Latreille declares that he could not find any such organ, and that he should consider it an anomaly in that

* "Piscibus ita hæret, ut eripi non possit, sugit ut hirudo, nec prius abscedit, quam tabidum et exsuccum piscem reddiderit, reperitur cervici mugilum, luporum, et saxatilium piscium affixus." (Libr. de Pisc. mar. Lugd. 1554, p. 576, "De Pediculo marino.") The woodcut at the head of Rondelet's article on *Pediculus marinus* represents an *Anilocra*, and approaches nearest to *A. mediterranea*, Leach.

† Hist. Nat. des Crust. in Dérerville's small edition of Buffon, ii. p. 208. The figure shows that the species on which Bosc has founded his description of the genus was a *Cymothoa* sens. strict.; Brünnich's "Fiskebjörn" (Entom. fig. 5), which he quotes, was more probably an *Anilocra*.

class of animals if it existed, and he suggests that perhaps the jaws protrude during the suction in such a manner that they may have been taken for a sucker*. Milne-Edwards has not entered on the question, but merely given some figures of the different parts of the mouth separately in *Æga*, and a more comprehensive series of illustrations of the mouth of *Cymothoa*†, some of which represent the parts in their natural connexion; all these figures are useful and good as far as they go, but they do not go far enough. We might expect to find more detailed information in Heinrich Rathke's anatomical essay on *Æga bicarinata*; but he says that the organs of the mouth are adapted for gnawing, and upon the whole constructed as in *Idothea*. He adds, however, that the terminal part of the mandibles is very hard, almost cuneiform, and strongly bent downwards, and, further, that the orifice of the mouth is remarkably small in proportion to the size of the animal. These two last statements, which are quite correct in themselves, do not seem easily reconcilable with the first, viz. that the mouth is adapted for gnawing, particularly as Rathke just before says that the mandibles adhere to the head to such an extent that their downward bent extremity cannot be capable of much movement‡. We shall nevertheless see, by-and-by, that each of the authors named, Bosc, Latreille, and Rathke, may be said to be right, to a certain extent.

With regard to the structure of the mouth in masticating Isopoda, we possess more ample information; and the descriptions and illustrations hitherto published, more especially those contained in Milne-Edwards's excellent works, suffice to give a tolerably complete idea of it. If, however, this information is to serve us as a safe guide to the interpretation of the sucking-apparatus of *Cymothoa* and its related genera, it will nevertheless be expedient to reconsider the subject once more, and to place before ourselves a succinct analysis of the principal types which may be observed in the structure of the mouth in masticating Isopoda. We shall preface this analysis with a few observations of a more general bearing.

3. The limbs of Articulata are, in their origin, mere hollow cylindrical prolongations of the skin, which are converted into levers by the deposition of as many and as extensive layers of chitine as the muscles of the animal require for their support, and divided into as many separate pieces as the mode of locomotion requires joints.

* Hist. Nat. des Crust. et des Ins. vii. p. 22.

† Le Règne Animal (éd. accomp. de pls.), pl. 65-67.

‡ Nov. Act. Acad. Cæs. Leop.-Carol. Natur. Curiosor. t. xx. pt. 1, 1843, pp. 26 & 27.

These prolongations take rise from the sides only of the rings of the body—that is, from the pleuræ or lateral folds between the dorsal and ventral plates; and in that case the pleuræ may be covered to a greater or less extent by a deposit of chitine forming a lateral plate, called the epimeron, which affords support for the muscles which move the basal joint of the limb, the hip or coxa.

It is also from the pleuræ alone that the peculiar prolongations arise which are in the service of respiration, either outside the body as gills or branchiæ, or inside as trachææ. From the dorsal and ventral arches of the rings, on the contrary, no limbs ever take rise, although they often carry other more superficial formations (which may also be subservient to locomotion) for the purpose of supporting or fixing the body, such as groups of sharp granules, indentations, spines, retractile warts, often with hooks disposed in circles, &c. To this last class belong the so-called ventral or false feet of many larvæ. The cerci of Insects with perfect metamorphosis (both of imagos and of larvæ) are merely transformed dorsal spines.

The head consists, as all the other rings of the body, of a dorsal arch, a ventral arch, and two side pieces. In this case, too, it is merely from the side pieces that the limbs take rise, namely the appendages of the mouth, and, besides, the eyes and antennæ. But as the head, besides one or two pairs of antennæ, possesses three pairs of limbs (appendages of the mouth), whilst none of the other rings have more than one pair, the lateral pieces or pleuræ of the head (cheeks and temples) preponderate so greatly over the dorsal and ventral pieces, that they occupy the greater part of the skull, particularly behind and above, where so much space is required for the accommodation of the muscular and nervous systems; whilst the dorsal and ventral pieces lose so much the more in extent as they are here relieved from the office they perform in all the other rings (saving the last of all), viz. to afford surface of insertion for the muscles which move the next following ring. The dorsal piece is therefore reduced to a plate above the mouth (the epistoma), from which separate pieces, viz. clypeus, labrum, labellum, are evolved in proportion as the mouth requires covering from above. The ventral piece, on the contrary (hypostoma, or the sphenoid plate, as it may be called from its analogy to the os sphenoidium of vertebrata), enters into closer relations with the appendages of the mouth, as will be shown more in detail by-and-by; from this, too, separate pieces are evolved in front, namely mentum and fulcrum labii, in proportion as the maxillæ and lingua with their muscles require support and cover from beneath.

The appendages of the mouth are consequently prolongations of the pleuræ of the head. In many Crustacea more or less marked pleural folds may be observed, one fold for each appendage, indicating that the head is composed of as many rings as it possesses appendages of the mouth.

The appendages of the mouth (oral limbs) consist typically of the following parts:—

(1) An articular fold near the base, the hinge (cardo). The corresponding articular fold at the base of the legs (or the limbs organized for locomotion) has been called "trochantin." In those insects where the coxæ at their base are surrounded by sockets, the trochantins form the condyles of the coxæ, being, as well as the latter, free of the epimeron.

(2) A stem (stipes), corresponding to the coxæ of the locomotive limbs, which is developed in proportion to the requirements of the lobes, its destination being to carry the latter and to accommodate the muscles by which they are moved.

(3) Three free lobes, at the end of the stem, of which the two innermost (malæ) serve for subdividing and handling the food and are therefore modified in accordance with the nature of the food. The third and outer lobe is the continuation of the limb as such, and corresponds to those divisions of the locomotive limbs which follow the coxa. When it is elongated and jointed, or shaped as a leg, it is denominated palpus; and its destination is then either to carry organs of sense, to produce currents in the water about the mouth, to cleanse the organs of the mouth, to serve as instrument of prehension, or some other such function.

4. A fundamental difference between Insects and Crustacea is now to be observed, in the relations of the first pair of oral appendages to the side pieces of the skull.

In *Crustacea* the mandibles do not exceed that point of development which is attained by the other appendages of the mouth, and consist like these of hinge, stem, and lobes. Their flexors are also, as far as the head is not united with the body, attached to the hypostoma, and their movement is an oscillation, which has for its axis the whole exterior margin of the stem, and which sometimes is regulated by an imperfect articulation at the exterior and posterior corner of the stem.

In *Insects*, on the contrary, both hinge and stem coalesce with the pleuræ of the head, and their proper muscles are not at all developed. The middle lobe alone remains, and articulates with the side pieces of the skull by an upper and a lower condyle, whilst its muscles fill a great portion of the side piece. The inner lobe is only very rarely developed, and is

then always fixed to the middle lobe. As there is no stem, there cannot be any mandibular palpus.

The development of the articulate archetype from the crustacean stage to the insect stage is here the same as that of the vertebrate archetype from fish to mammalia; and this analogy may also be traced in several other respects. In both these series of animals the cephalization is furthered by this, that the principal organ for the handling of the food gradually loses its form of limb by the coalescence of its basal divisions with the side pieces of the skull; in this way these latter gain additional space for accommodating the nervous system, whilst the movement of the jaws at the same time increases in power, because the muscles of the basal divisions of the limb disappear, and all the space on the increased side pieces of the skull is available for the muscles moving the remaining terminal parts of the jaws. The cephalization of the oral limbs of Vertebrata (the lower jaw) may be observed in different stages in reptiles and birds; the same is the case with the mandibles of Articulata. One of the intermediate stages, found in the lower Insects, with imperfect or no metamorphosis, and in sucking Insects, has recently been pointed out by Dr. Meinert in his paper on Campodeæ*.

5. In the hedriophthalmous or fourteen-footed Crustacea the first ring of the trunk† is connected with the skull, and as it ceases to be moveable its dorsal part (pronotum in Insects) disappears, whilst the ventral and lateral parts (prosternum and epimera prothoracica) still remain as separate pieces between the head and the second ring, because they carry a pair of limbs, the fore legs, which enter into the service of the mouth, and therefore assume the shape of maxillæ. These mouth-feet or maxillipeds have their coxæ in proximity to each other in the middle, and correspond thus far to the labium of Insects, that they afford a cover for the mouth from beneath, and assume a similar foliaceous and lacinated shape. Fabricius and his school therefore called them labium, as their morphologic interpretations were based only on the shape and use of the parts.

Next to the coalescence of the stems of the mandibles of Insects with the side pieces of the skull, there is no more important point of difference between the structure of the mouth in Insects and in hedriophthalmous Crustacea than precisely this conformation of the maxillipeds simulating a labium. Covering as it does the mouth from beneath, the existence of this false labium renders unnecessary any other cover; consequently

* Translated in Ann. & Mag. Nat. Hist. ser. 3. vol. xx. p. 361.

† In this paper the expressions "trunk" and "tail" stand for "thorax" and "abdomen" in the terminology of Milne-Edwards and others.

no mentum is evolved from the sphenoid plate, and the tongue, rising from the bottom of the cavity of the mouth, appears immediately over the edge of the sphenoid plate; nor do the ordinary oral appendages of the third pair (second pair of maxillæ) enter into any combination with the tongue as they do in Insects, but remain separate, each on its own side of the sphenoid plate. The consequence is that the tongue occupies a far more advanced place among the organs of the mouth than in Insects. Whilst thus the first great peculiarity of the head in hedriophthalmous Crustacea (its being finished off underneath by labium-like maxillipeds) exercises a very marked influence on the structure of the mouth, causing, so to say, a pressure from beneath, the second great feature distinguishing their head from that of Insects, viz. the free position of the mandibles with regard to the skull, produces a similar pressure from above, and both together result in imparting to the intervening organs of the mouth (the two pairs of maxillæ and the tongue) their characteristic flattened and foliaceous appearance, and in placing the tongue in a very peculiar position to the mandibular lobes, determining its form once for all. The complete severance of the Insect head from the body, which entails its being finished off from beneath by the combination of the third pair of oral appendages, the mentum and the tongue, into a labium, finally its considerably increased thickness, which is caused by the coalescence of the stems of the mandibles with the side pieces of the head—all these circumstances cause the maxillæ and the tongue to be placed on a so much lower level than the mandibles (supposing these to lie horizontally), that the tongue retains free space to develop itself in accordance with manifold and various secondary considerations. But in the head of Crustacea the first pair of oral limbs, being entirely separate from and outside the side pieces of the head, are depressed into a lower level than that of the sphenoid plate, which lies very high; and consequently the tongue is placed *above* the mandibular lobes, and cannot possibly have any other than a deeply bifid shape, as it would otherwise close the aperture of the mouth.

6. The mouth of biting Isopoda presents three principal types, which agree in this, that the oral limbs are placed in a row slanting outwards and forwards on either side of the sphenoid plate, each independent of its neighbours.

The first type comprises Onisci, Aselli, Idothææ, and Sphæromata. It is essentially the same as the one we meet with in the majority of Amphipoda, that is, upon the whole in those Edriophthalmia which live near the shore or on the bottom of the sea, and feed upon carrion or vegetable food, gnaw wood, attack fishing-nets, &c.

The mandibles have two lobes. The outer lobe is continued into a slender prehensile part, which is split into two or more branches; and these latter are again divided into digitiform teeth; at the base it possesses a large grinding-tooth of varying shape and armature. The inner lobe is very short, more or less subdivided into smaller lobes and fringed, generally membranaceous, sometimes partially or wholly chitinized in one mandible and membranaceous in the other. The stem is more or less developed according to whether it has to carry a palpus or not. The first pair of maxillæ have two slender lobes, both moveable, particularly the inner one; this latter carries on its apex a number (generally four) of cylindrical, pointed, soft, hairy appendages, whilst the apex of the outer lobe is armed with a number of sometimes exceedingly sharply pointed, sometimes perfectly blunt, sometimes spinulous thorns. The second pair of maxillæ have from one to three lobes, of which at least the two outer ones are moveable, the outermost being sometimes palpiform.

As an example of this type, which, moreover, is the best known of the three, we may take a little *Sphaeroma* which is very common along the coast of Denmark, but does not seem to have been sufficiently well described as yet; perhaps it is identical with *Oniscus globator*, Pallas (Spic. Zool. fasc. ix. p. 70, pl. 4. fig. 18). The prehensile part of the mandible is split into two branches, each with three to four digitiform teeth, which fit in between those of the mandible on the opposite side (Pl. I. fig. 1, *m*). The grinding-tooth is grooved and surrounded by a fence of spines. The inner lobe is small, soft, with pointed digitiform lobes, and articulates with the underside of the outer lobe in a depression between the prehensile part and the grinder. The stem of the mandible is short; its outer part contains the muscles of the palpus, whilst its own flexors are inserted in its inner section. The palpus is rather short and thick, but free. The stem of the first pair of maxillæ is divided longitudinally by a groove into two sections containing the muscles of the two lobes; the inner lobe (fig. 1, *x*) has four cylindrical, pointed, soft, hairy, membranaceous smaller lobes, whilst the terminal spines of the outer maxillary lobe are broadly truncate, some of the inner spines bearing spinulæ on their inner side. The second pair of maxillæ (fig. 1, *x**) possess three short lobes, of which the outer one forms a foliaceous biarticulate palpus.

7. The second type is characteristic of *Cirolanæ*; and as illustrative examples we may take *Cirolana borealis*, Lilljeb., from the North Sea and the Kattegat, and a pretty little active species ornamented with stars of black pigment, which

occurs not unfrequently in the Sound and along the north coast of Zealand. It was already known to Slabber, and was described some years ago by Van Beneden ("Rech. sur les Crustacés de Belgique," Mém. d. l'Acad. Belge, xxxii. p. 88, t. 15) as *Slabberina agata*, but is doubtless the same species that Leach described as *Eurydice pulchra*. Van Beneden refers it to *Idothea*.

The mandibles are destitute of grinders; but their prehensile part is, on the contrary, extraordinarily large, shaped like a flat cup, the outline being almost quadrangular, the outer corner pointed, the whole inner edge finely sharpened, hard as glass, undulato-dentate, the inner corner drawn out into a long dagger-like peg. The inner lobe is fixed closely under the outer lobe, large, membranaceous, divided into two lobules, of which the foremost is entire and covered with setæ in *Cirolana*, but digitilobate in *Eurydice*; whilst the posterior lobule in both genera is cultelliform, with a close row of pointed thorns along the inner margin, which gives to the lobule the appearance of a tenon-saw. The stem of the mandible is long, the palpus slender, and, when not used, placed in a groove round the large labrum and the small clypeus, with the last joint slung round the root of the posterior antenna. The first pair of maxillæ possess two lobes coalescing with the stem; the inner lobe is much abbreviated and has three cylindrical slender appendages, which in *Cirolana* are verticillato-spinulous towards the apex, and furnished with a hard thorn-shaped terminal joint, but which in *Eurydice* are soft, pointed, and hairy; the outer lobe is also rather short, particularly in *Cirolana*, somewhat arched inwards (fig. 3, *x*), powerful, the apex armed with a bundle of long, exceedingly hard, and pointed thorns, groups of similar thorns occurring all along the inner margin, which, in *Eurydice*, are much elongated and in part spinulous on the inner side. The second pair of maxillæ (fig. 3, *x**) are small, their inner lobe very short, with feather-like setæ and hairy membranaceous digitiform appendages; the middle lobe and palpus are represented by a pair of uniform pointed leaflets. The maxillipeds (fig. 3, *px*) have oval hinges, small stem, rudimentary lobes, and fully developed, slender, flat palpus. The forehead and clypeus are, in *Cirolana*, trapezoid, flat, in *Eurydice* vaulted, the frontal cone protruding between the first pair of antennæ (fig. 3 *a, f*).

Cirolanæ represent, no doubt, the highest development of the Crustacean type amongst Isopoda. The outer lobes of their mandibles are built exactly on the same plan as the carnassial teeth of mammalia. They are furnished with pegs to be driven into the body of the victim, one from either side,

and to distend gradually the piece which lies between them, until it is cut through by the cutting edges which glide clipping past each other. In harmony with this structure of the mouth is the slender form of the body, the thin antennæ, and the well-developed swimming-feet; and it cannot be doubted, therefore, that *Cirolanæ* are purely carnivorous. The testimony of different authors goes in the same direction. Thus we find in Ström's physical and topographical description of the district of Söndmör, in Norway, a description of a "Fish-Bear," which must be a *Cirolana* (*C. borealis* in all probability), and which, he says, "creeps into the fishes through the anus and eats the flesh of the fish from the inside, so that, if it only has time, it may eat the whole of the fish." The author of this paper asked Professor Krøyer, the celebrated and experienced connoisseur of Crustacea and Fishes, whether he remembered any fact confirming the conclusions as to the mode of living of *Cirolanæ* which are suggested by the structure of their mouth; and Professor Krøyer then related that once, near the shores of Norway, not far from Thronthjem, he caught a large codfish which teemed with *Cirolana borealis*. The latter had eaten out such large cavities in the flesh that there was little left of the fish except skin and bones. In the hurry to secure this rich harvest Professor Krøyer tried to help himself by keeping some of the parasites in his closed hand, but they bit him so ferociously that he was obliged to let them go at once.

8. The third type is that of *Serolides*, of which *Serolis Orbignyana*, M.-E., may serve as an example. The stem of the mandibles (fig. 2, *m*) forms a very large, flat, oblique, quadrangle placed in a slanting position, and is evidently almost exclusively destined to give room for the insertion of the flexors, as the palpus rises from the exterior and posterior corners. The outer lobe has a similar shape, but is somewhat pinched off from the stem in the place where the large labrum begins to cover it in front; there is no grinder, and the prehensile part is thick and slightly spoon-shaped, the apex broadly truncate, with thick rounded edge; the inner margins of the mandibular lobes on the right and left sides meet each other accurately, but do not cross so as to cover each other. The inner lobe is small, divided into two lobules, which are attached to the outer lobe close under its prehensile part. On the right mandible both lobules are very small, soft, bipartite; but on the left mandible the foremost lobule is much increased in size, thickly chitinated, and resembles the prehensile part of the outer lobe by its clumsy, rounded transverse edge. The mandibular palpus is long, slender, the two first joints fitting into a shallow groove running along the outer margin of the stem and continued between

the clypeus and the base of the posterior antennæ, so that the small terminal joint projects between the antennæ. Both pairs of maxillæ are small, completely covered by the large and flat maxillipeds. The first pair of maxillæ exhibit only one narrow lobe (the middle lobe), which is armed at its apex with a few fine spines. The second pair of maxillæ have three small, narrow, and inarticulate lobules, of which the middle one and the external one or palpus are moveable. The cardo of the maxillipeds (fig. 2, *px*) is very large, transversely placed, and divided by membranaceous seams into several plates; the stem is small and short, but has a large foliaceous prolongation on the outer side, whereby the base of the stem becomes as broad as the anterior margin of the cardo, so as to produce the impression that the cardo here lies behind the stem, whereas it really lies, as usual, obliquely outside it; the short adnate lobes form in connexion with the stem a thick crest on the upperside, which is made to fit alongside a ridge, which on either side marks the outline of the broad sphenoid plate. This latter is at the base carinate and at the apex deeply bifid. The palpus is short, thick, biarticulate.

If, now, the clipping and tearing mouth and active appearance of *Cirolanæ* forcibly suggests the idea of a small shark, it is difficult to contemplate the *Serolides* without thinking of a little ray or skate. That they live near the bottom is sufficiently evident from their broad, short, slightly vaulted general form, the crested and carinated dark-coloured back, the smooth white under surface, the sickle-shaped imbricate epimera, the flat broad head which is closely fitted into the first segment of the body, the salient eyes placed on the upper surface of the head, the position of the mouth on the under surface, and the limited capability of swimming. Besides, their mandibles, though powerful, are not arranged either for clipping, grinding, or masticating, but only for pinching or squeezing and biting through a hard surface; the maxillipeds cover up the other, very small, appendages of the mouth; and after them follow two pairs of prehensile limbs of the same kind as those of *Mantis*, *Nepa*, and *Squilla*. It cannot, therefore, be doubted that *Serolides* live upon prey, and that this consists of small rather slow animals living near the bottom, probably mostly such as have firm integuments. The hypothesis suggested by Milne-Edwards (*Hist. Nat. des Crustacés*, iii. 231), that they attach themselves to fishes, is contradicted by the very feature of their structure to which he refers in support of it. Their flat mouth would be powerless against the skin of a fish, even if the cup-like shape of the anterior parts of the body did not prevent the mouth from reaching the skin. Furthermore, the first pair of

body-limbs are not hooked, but long prehensile organs, articulating with the body in such a manner that they can reach far forward in order to catch objects, and then, folded together, keep that which has been caught closely under the mandibles; the second pair of legs, which have the same shape but in a smaller size, are to be considered merely auxiliary organs.

9. These three types may consequently be surveyed according to the subjoined scheme:—

Instrumenta cibaria mordentia, libera, serie obliqua utrinque disposita. Hypostoma breve. Orificium oris amplum. Mandibulæ malis binis instructæ, exteriore fixa.

A. Mala exterior mandibularum mola instructa striata, mucronulata spinosave.

a. Os manducatorium.

Mala exterior mandibularum ramosa, digitate spinosa, prensoria.

Maxillæ priores malis binis, exteriore subrecta, apice spinulosa.

Onisci, Aselli, Idotheæ, Sphæromata.

B. Mandibulæ mola carentes.

b. Os sectorium.

Mala exterior mandibularum depressa, quadrata, margine interiore acutissimo, valide dentato.

Maxillæ priores malis binis, exteriore incurva, multispinosa.

Cirolanæ.

c. Os morsorium.

Mala exterior mandibularum crassa, fornicata; margine crasso, obtuso, edentulo.

Maxillæ priores mala unica, apice spinulosa.

Serolides.

10. Thus prepared, we may with greater confidence enter upon an examination of the structure of the oral sucking-apparatus in Cymothoæ. As examples we may take two often-described species, *Æga psora*, L., and *Cymothoa cæstrum*, auct., which represent the two types round which all the other Cymothoæ gather themselves with regard to the construction of their sucking-apparatus. For the sake of comparison I also take into account the *Anilocra Leachii*, Krøyer, a new species from the West Indies, which approaches very near to *A. laticauda*, M.-E. (Hist. Nat. des Crust. iii. 259. 6), besides a small species nearly related to *Cymothoa* sens. str., which was collected by Professor Krøyer, in Feb. 1840, on a fish caught

in the Plata River, but of which the specific name was not determined. As this Isopod is apparently undescribed, and rather remarkable, I here insert its chief characteristics.

I propose to call this species *Artystone trysibia*. It reminds one somewhat both of *Urozeuctes* and of *Olencira*, but is easily distinguished from the other genera of the family by the striking contrast between the first six pairs of legs, which are short and hooked, and the seventh pair, which reach to the extremity of the tail and are slender, compressed, crawling legs with small, almost rudimentary, straight claw. The trunk is slightly vaulted, broadly elliptic, the fore part somewhat twisted to the left, the hind part twisted still more to the right. The head is small, resembling that of *Cymothoa cæstrum* in all essential points; and the same holds good with regard to the antennæ and the organs of the mouth. The anterior corners of the first ring scarcely reach the eyes; the greatest breadth of the animal is between the fourth and the fifth ring, where it is about half the greatest length. All the rings of the trunk have a couple of small, triangular, irregular, lateral folds over the epimera, which latter are luniform, rounded before and behind, extending on the first four rings as far as about one-half of the lateral margin of the dorsal plate, on the fifth reaching almost the whole length of the margin, and on the sixth and seventh somewhat beyond the dorsal shield. The coxæ are even, without protuberance, the hooked legs small, almost of equal length, their claws very fine. The first five rings of the tail are very short, of uniform length, somewhat increasing in breadth behind, the first three covered by the seventh ring of the trunk; the last caudal ring is gradually narrowed from the base, obliquely triangular, of about equal length and breadth, rather high-arched, with rounded apex; the last pair of caudal legs reach not quite to the apex of the ring; the branches are of equal size, elongated elliptic, soft, naked. The total length is 13 millims. The colour is white; on the trunk very minute points of black pigment are observable on the side folds of the dorsal shields, on the last three pairs of epimera, and across the dorsal shields along their posterior margin; vestiges of similar points are seen in a streak along the tail and on the base of the last joint. The only specimen found is a female with ripe eggs; the opercula are as in *Cymothoa cæstrum*.

This parasite seems to indicate even a more direct transition to the Bopyri than the twisted *Livonecæ*.

11. In *Cymothoæ* the organs of the mouth are adapted for sucking in the following manner. The labrum is elongated, transversely curved so as to form a semicylindrical duct, which

is turned perpendicularly downwards and on the sides joins the maxillary lobes of the second pair, which also are converted into a semicylindrical duct, and of which the ends are expanded into a sort of lip; the palpi of the maxillipeds sometimes also enter into the combination. Thus a short soft tube is produced, which, by means of fringes, warts, and small hooks round the aperture, is specially adapted for closing tightly against a surface. Inside this tube we find foremost a pair of instruments designed for stinging, clipping, cutting, gnawing, or scratching, and which are the transformed mandibles; and behind them, again, a pair of fine saws or rasps are seen, by means of which the wound made by the mandibles may be further extended, lacerated, or deepened; this second set of instruments is formed by the first pair of maxillæ.

As regards the mandibles, the conversion is effected in the following way:—the stem is elongated, its sliding articulation at the base disappears, and it becomes almost immoveable; the inner lobe disappears entirely; the outer lobe is twisted abruptly downwards and forwards, separating itself from the stem by a short neck, in which there is an imperfect membranaceous articulation, and penetrates at once, just at the bend, into the interior of the sucking-tube, slipping in from the side between the labrum and the expanded ends of the second pair of maxillæ; the lower part of this lobe, which consequently is inside the sucking-tube, assumes the shape either of a triangular, pointed, at the apex sharp and hooked scratching-instrument (*Ega*), or of a thin, triangular, pointed knife-blade (*Cymothoa*). Although the stem of the mandible, on account of its limited mobility, only requires small space for its own muscles, it nevertheless retains a considerable size, as it must accommodate not only the muscles of the palpus, but also those of the moveable lobe, of which, however, the muscles also combine with those belonging to the second pair of maxillæ. Upon the whole, it may be observed that the masticating muscles of Crustacea are, as is also the case in fishes, combined and coalescent with each other to that degree that it becomes difficult to distinguish between their different portions, and all the organs of the mouth are really moved collectively to a certain extent. The maxillæ of the first pair are reduced to slender stiff stylets, surrounded and hidden by those of the second pair, of which the lobes in front meet in the middle; the stylet is formed by the stem and the moveable middle lobe, which on the apex carries a number of pointed hooked thorns.

A more detailed description of the mouth in *Ega* and *Cymothoa* will serve to place this account in a clearer light.

12. When the mouth of *Ega* is examined from beneath,

the *maxillipeds* at once arrest the attention. The *cardo* (Pl. I. fig. 4 *b, c*) is expanded outwards and forwards into a large triangular plate, which covers the root of the second pair of maxillæ. The stem is very large, elongated, quadrangular (fig. 4 *b, s*), its underside slightly vaulted; but the lateral or outer portion is boldly arched upwards, so as to embrace the maxillæ of the second pair; and the upper surface of the stem has near the inner margin a thick longitudinal crest fitting so accurately into a depression on the corresponding side of the middle ridge of the sphenoid plate between this ridge and the maxillæ of the second pair, that the stem by these means is kept quite firmly in its position. On account of this crest, the stem appears rather thick when detached and viewed from the side of the inner margin, which latter is quite straight and even, so as to fit in exactly with the corresponding margin of the maxilliped on the opposite side, to which it lies close through the whole of its length.

The five-jointed *palpus of the maxillipeds* (*p*, fig. 4 *b*) is of about the same length as the stem. The first joint is very short, and is placed transversely in front of the fore end of the stem, whilst the four following joints form a bluntly pointed, inwardly curved, cup-shaped leaf, which rests on one edge, so that it inclines a little inwards. The upper (and outer) even edge of the leaf fits first into a narrow groove on the inner edge of the stem of the mandible, and then passes round the mandible and lays itself into the bend between the mandibular stem and lobe, whilst the front edge is curved inwards and embraces the corresponding side of the labrum. On the inferior margin of the palpus, near the end of the second joint, a couple of small soft hooks are implanted; and a greater number of such are distributed along the margin and along the outer side of the following joints. They do not, however, appear as hooks, except when viewed from the side, and particularly when the palpus is pressed flat; but from beneath or from the side, when the palpus is in its natural shape, they are seen fore-shortened, and then appear as a row of short thorns along the margin of the third joint, and as a lump of warts on each side of the labrum.

In this manner the two leaves formed by the palpi, placed on edge and bending towards each other, embracing some other parts of the mouth, constitute the sides of the sucking-tube. Nevertheless a slit remains between them; but this is filled up at the bottom by the two very short, conic, compressed, brevisetose lobes of the maxillipeds, and, further, in front by the inner lobes of the second pair of maxillæ, which will afterwards be described.

In front the oral tube is closed by the *labrum*, which hangs perpendicularly from the clypeus; this latter is itself in a perpendicular position, elongated and arched in front. The labrum is of semicircular outline, and edged by a thick, soft, membranaceous fringe, which is dotted over with small pointed warts.

When the maxillipeds are removed, we observe the short prosternum, and in front of it the sphenoid plate, on which an elevated ridge is conspicuous along its middle line, which becomes gradually thinner towards the apex, besides the sockets of the cardo and stem of the maxillipeds, and, finally, the *second pair of maxillæ*. As we have stated already, a depression is observed on either side between the latter and the middle ridge of the sphenoid plate, which is filled up by the longitudinal crest on the upper surface of the stems of the maxillipeds. The consequence is that the stems of the second pair of maxillæ are entirely covered in from beneath by the stems and the base of the palpi of the maxillipeds. The stems of the second pair of maxillæ present the shape of elongated, inverted-pyriform, thin and uneven saucers, somewhat narrowed and flattened towards their fore ends, which meet across the middle ridge of the sphenoid plate, just inside and above the second joint of the palpi of the maxillipeds. Their concavity is, of course, turned upwards towards the under surface of the skull; and in the space thus enclosed the maxillæ of the first pair are lodged, with sufficient spare room to insure their free movement. The maxillary lobes of the second pair are small, thin, of rounded outline, at the apex and along the inner margin armed with some small, rather soft, hooked spines. The rounded outline of the lobes, however, only appears when they are unfolded; for in their natural position their appearance is very different. The inner lobe is then observed (*x**, fig. 4 *b*) in the slit between the palpi of the maxillipeds, at the inner posterior corner of the second joint; but it is twisted round, so that it is seen foreshortened, and the hooks above mentioned seem in consequence to form altogether but one thick thorn. The whole anterior margin of the outer lobe, on the contrary, is turned back like a collar over the anterior margin of the second joint of the maxillipeds. The part played by the second pair of maxillæ in the construction of the sucking-apparatus is consequently this, that their stems are excavated into sheaths for the styliiform first pair of maxillæ, and their lobes fill up the remaining gaps in the sucking-tube, of which the opening becomes a closed circle formed by different elements which can slide over each other and are armed with small hooks.

It remains to examine the structure of the bottom of the sucking-tube—that is, the region about the real mouth of the animal. We then find that the sphenoid plate reaches as far forward as the apex of the second joint of the palpi of the maxillipeds; here the ridge, already mentioned as running along the middle of the plate in question, bifurcates into two soft branches, lying close together, which coalesce with the lobes of the tongue, forming their thick inner margins, and presenting, with the open slit between them, the exact figure of a buttonhole. The two round, naked, soft, and slightly folded lobes of the tongue, which resemble flat cushions, fill entirely the small space between the sphenoid plate behind, the palpi of the maxillipeds on the sides, and the labrum in front, whilst their abruptly attenuated, short and conic ends are turned downwards and slung round the fore parts of the mandibles. The sucking-tube would thus be completely closed at the bottom, if the just-mentioned buttonhole-like slit between the lobes of the tongue did not remain; and this slit must therefore be considered the real sucking-orifice.

We have thus traced the ways in which all the necessary conditions for the hooking on and loosening, the contraction and extension, abbreviation and prolongation of the mouth-tube are supplied and combined into one collective whole, and we can now pretty well understand how this animal is enabled to suck. The mouth-tube itself is so constructed that it may serve as a sucking-cup; further in we meet the tongue with its buttonhole and nothing more, therefore, is required than swallow-movements of sufficient strength to cause a liquid to ascend into the cesophagus. It is indeed most probable that the anterior, pear-shaped part of the intestine, concerning which Rathke (*l. c.* p. 30–31, t. 11. figs. 16 & 17 *a*) expresses himself with some uncertainty, is of great importance in the act of sucking. It still remains to consider a little more closely the instruments by means of which the source of liquid is made to flow.

The stem of the *mandibles* (*s*, fig. 4 *c*) forms a very large, flat cone, with somewhat sinuated outline, slanting forwards and inwards, bearing the palpus near its posterior and exterior corner, and lying uncovered between the maxilliped and the labrum, as far as the place where it penetrates into the mouth-tube from the side. At this point it is immoveably adnate, and affords thus a firm lateral support for the mouth-tube; but immediately inside it is abruptly contracted and twisted half round with a downward bend; and here the membranaceous articulation of the stem with the mandibular lobe is

situated; this latter consequently projects downwards inside the mouth-tube, just behind the labrum, and beneath the corresponding lobe of the tongue, which forms the bottom of the mouth-tube. The lobe of the mandible (*m*, fig. 4 *c*) is elongated triangular, gradually acuminate, with convex back and concave front, the sharp lateral edges meeting at the sharp-pointed hooked apex. The muscles of the lobe fill the greater part of the stem in front of the insertion of the palpus. This arrangement, in connexion with the corresponding great length of the stem, indicates great power and perseverance of movement, and explains how these lobes, in spite of their inconsiderable size, may be used with great effect. Their shape and position enables the animal to sink them into its victim, one from either side, in slanting converging directions, and then, by drawing them back simultaneously with sufficient strength, to tear out the piece which lies between them. That they are destined to work against each other and to be drawn back together is plain from the circumstance that their points are not quite uniform, the left hook being somewhat more bent than the right one, and at the same time a little twisted to the side, so that it can take hold round the other.

The sawing-styles, or *maxillæ of the first pair*, consist each of a shorter stem and a longer lobe, which joins the former evenly all round. They are hard, smooth, slightly flattened, and bent inwards, so that their ends project downwards in the mouth-tube, behind the mandibular lobes, under the tongue, and on either side of the buttonhole-shaped sucking-slit. The seven hooked spines at their apex are so placed as to form a curved group; and it is therefore difficult to make out their form and number except when the lobe is pressed. These sawing-styles are evidently intended to act as auxiliary instruments, for deepening, increasing, and lacerating the wounds made by the mandibular lobes.

The long and slender *mandibular palpi* (fig. 4 *a*) are, when at rest, placed firmly against the head in a groove on the underside of the skull, which runs at a little distance from the stem forwards between the forehead and the posterior antennæ, round the basal joint of which their pointed and sickle-shaped terminal joint coils itself. The palpi, being inserted so far behind and to the side that they have considerable room for play, are probably destined for cleaning the mouth-tube with the brush at their apex, and to comb away the fishy slime from the marginal hooks by means of the fine comb of spines implanted in the outer margin of the terminal joint.

The structure of the mouth in *Æga* may therefore be described in the following terms:—

Æga.

Os haustellatum.

Haustellum adversum clypeo labroque, aversum malis posterioribus palpiisque pedum maxillarium confectum, malas mandibulares maxillaresque priores rasorias involvens.

Clypeus fornicatus pendulus.

Labrum semicirculatum, pendulum, fornicatum, margine membranaceo, fimbriate verruculoso.

Mandibula stipite amplo, falcato, basi palpigero, *mala interior* nulla. *Mala exterior* sub labrum oblique inflexa, mobilis, in orificium haustelli deorsum eminens, triquetra, acuminata, intra concavinscula, apice extremo hamato, acuto. *Palpus* gracilis, triarticulatus, articulo intermedio producto, terminali brevi, falcato, barbato, pectinato, basin antennæ secundæ amplectente.

Maxillæ priores stiliformes, *mala interior* et *palpo* nullis. *Mala exterior* stipiti contigua, in orificium haustelli deorsum eminens, fasciculo armata terminali hamorum rasiorum.

Maxillæ posteriores apice contiguæ, maxillas priores obvolventes, stipite lato, fornicato, *palpo* nullo. *Malæ* discretæ, breves, rotundatæ, margine minute hamulatæ, orificium haustelli post claudentes, supra marginem interiorem palporum pedum maxillarium reflexæ.

Pedes maxillares maxillas includentes, cardine maximo, obliquo, laminato, triangulo, mala minutissima, conica. *Stipites* contigui, recti, subquadrati, fornicati, supra carinati, hypostoma valde elongatum medio carinatum utrinque explentes. *Palpi* quinquearticulati, latissimi, foliacei, fornicati, infra minute hamulati, labia lateralia haustelli formantes.

Lingua rotundata, mollis, pulvinata, nuda, fissa lobis apice lingulatis, introrsum arcte contiguis, crasse marginatis, rimam suctoriam includentibus.

13. Having now described the structure of the mouth in *Æga* as minutely as seemed necessary in order to explain its composition and mode of action, we may, in respect of *Cymothoa* (fig. 6), content ourselves with a comparison between the two, pointing out and interpreting the differences.

The oral tube is built up of the same elements; but they enter into its composition in different proportions; and an important difference in this respect is to be noticed between the two sexes.

In the *male* the cardo of the *maxillipeds* is a large, transversely oval but very irregular plate. The stem is flat, ob-

long, narrower in the fore part, with a small protuberance on the outer margin, which touches the stem of the mandibles, and is somewhat vaulted, but does not by any means cover in the stems of the second pair of maxillæ so completely as is the case in *Æga*. The stems of the two maxillipeds meet, as in *Æga*, with their even inner margins, and likewise fit in between the middle ridge of the sphenoid plate and the second pair of maxillæ, by means of a crest on their upper surface; but this is considerably narrower than in *Æga*. The palpus is small, pointed, biarticulate, slightly curved inwards, with a row of small hooked spines on the inner or lower edge of the terminal joint. The upper or outer margin of the palpus is also in *Cymothoa* arranged to fit into a groove in the stem of the mandible, and forms the side margins of the mouth-tube.

In the *female*, on the contrary, the maxillipeds are converted into a pair of thin lamellæ, which are almost entirely covered from beneath by the first pair of plates of the egg-bag, and which do not reach so far that the palpi can form part of the mouth-tube; the cardo, besides, has a foliaceous inward-turned prolongation; and, as the inner margins of the stems, moreover, are not quite rectilinear, the stems do not meet accurately along the middle line of the skull, and it is only on a short piece that they fit in above between the ridge of the sphenoid plate and the second pair of maxillæ. Each of the stems, besides, expands on the outer side into a large, thin, rounded leaf, which reaches forward a considerable distance beyond the small palpus, of which only the last joint has a few thorns at the apex.

In both sexes the maxillipeds are without lobes: the inner corner of the stems certainly presents a little eminence, which is particularly easily observed in the male; but it lacks setæ, and can consequently hardly be looked upon as a lobe.

Of course this great sexual difference in the structure of the mouth entails a corresponding difference in the part taken by the maxillæ of the second pair in the composition of the mouth-tube.

The peculiarity of the *second pair of maxillæ* in *Cymothoa* consists in this, that the lobes are neither separate lobules as in *Æga*, nor turned back in the shape of collars, but they coalesce with one another, are soft, swelling, and by slight longitudinal grooves divided into small oval cushions (three on each maxilla), which together form the posterior part of the orifice of the mouth-tube. The outermost cushion has on the outside and at the apex a scattered number of small pointed warts; the intermediate and innermost cushions have no warts except on the margins, but have besides in their fore

part some few hooks—the middle one three, the innermost only one.

In the male *Cymothoa* the sides of the mouth-tube are, as we have stated, supplied by the maxilliped-palps, which reach as far as the labrum; and the maxillary lobes of the second pair have therefore here, as in *Ega*, no other duty than to fill up the slit between the maxilliped-palps, though certainly this opening is proportionally larger in *Cymothoa*, the palpi in question being smaller and the lobes of the maxillipeds wanting. But in the female *Cymothoa*, where the maxillipeds do not enter into the construction of the mouth-tube, this devolves entirely on the second pair of maxillæ (*x**, fig. 6 a; the maxillipeds are removed). These are therefore much broader than in the male; their stems meet in much greater extent, namely with the whole of their front halves, and the lobes form together a large curved lip, which, on the sides, joins the labrum.

Although this conversion of the maxillary lobes of the second pair into a kind of lip in all essential points makes up for the non-participation of the maxillipeds in the construction of the mouth-tube in the female, and their limited participation in the male, this expedient would, nevertheless, not be sufficient if the labrum in *Cymothoa* were not larger than in *Ega*. But whilst in this latter genus the labrum occupies only one-third of the circumference of the mouth-tube, it supplies in *Cymothoa* quite one-half. It is consequently much broader, much more considerably arched from the top downwards, so that it becomes like an inverted cup when the mouth-tube is contracted; a small undulation is then also observed in the middle of the margin, which latter is furnished with numerous minute warts. But when the mouth-tube is distended and examined from beneath, the margin appears undulated or crenate.

From all this it appears that the mouth-tube is, upon the whole, softer and less powerfully armed in *Cymothoa* than in *Ega*: instead of the almost fringe-like covering of warts on the labrum, the considerable bundle of hooked spines on the palpi of the maxillipeds, and the row of spines on the turned-over margin of the maxillary lobe of the second pair in *Ega*, we find in *Cymothoa* merely the very minute warts on the very edge of the labrum and on the cushion-like lobes of the second pair of maxillæ, and the very short row of hooked spines on the two innermost cushions of these lobes and on the margin of the terminal joint of the maxilliped-palpi in the male. But this weaker armature of the mouth in *Cymothoa* of course cor-

responds with the far greater development of the hooked limbs in that genus, to which we shall allude further on.

The *mandibular palpi* (*m*, fig. 6 *a*), on the contrary, enter into far closer connexion with the mouth-tube in *Cymothoa* than in *Æga*. Instead of being slender and furnished with a brush of bristles and a comb of spines as in *Æga*, they are short, thick, and conic, and they are inserted on the stem in such a manner that they become directed straight forward. They are accordingly applied to a different purpose, namely to the support of the mouth-tube, round which they lie closely, meeting in front of it and embracing it between them. In *Anilocra* (fig. 5) this destination of the mandibular palpi is still more apparent in their form, the joints of the palpi being so accurately fitted to the space between the antennæ and the labrum that they surround the mouth-tube as a kind of padding.

Excepting that the sawing-styles formed by the *first pair of maxillæ* (fig. 6 *b*) are less powerfully armed than in *Æga*, the difference in the inner machinery is confined to the structure of the *mandibular lobes* (*m*, fig. 6 *b*), which are thin, triangular, pointed lobules, with a sharp inner edge, and are doubtless used not merely for stinging, but also for the purpose of clipping, as they are capable of being crossed like the blades of a pair of scissors.

The formula for *Cymothoa* will consequently be the following :—

Cymothoa.

Os haustellatum.

Haustellum adversum clypeo labroque, aversum in fœmina malis posterioribus, in mare malis posterioribus palpisque pedum maxillarium confectum, malas mandibulares punctatorias maxillaresque priores rasorias involvens.

Clypeus fornicatus, pendulus.

Labrum amplum, semicirculatum, pendulum, fornicatum, margine minute verruculoso.

Mandibulæ stipite quadrato, fixo, apice palpigero, mala interiore nulla. *Mala exterior* sub labrum oblique inflexa, mobilis, in orificium haustelli deorsum eminens, triangula, compressa, acuminata, cultriformis. *Palpus* labrum utrinque amplectens, triarticulatus, conicus, nudus; articulis sensim decreascentibus.

Maxillæ priores stiliformes, mala interiore et palpo nullis. *Mala exterior* stipiti contigua, in orificium haustelli deorsum eminens, fasciculo armata terminali hamorum rasiorum.

Maxillæ posteriores fere totæ contiguæ, maxillas priores obvolventes, stipite lato fornicato, in foemina latissimo, palpo nullo. *Malæ* concretæ, membranaceæ, pulvinatæ, minute hamulatæ, fornicatæ, in mare marginem interiorem palporum pedum maxillarium fulciantes, in foemina orificium haustelli post claudentes.

Pedes maxillares maxillas tegentes, laminati, cardine maximo irregulari, mala nulla. *Stipites* planiusculi, in foemina extorsum dilatate foliacei, in mare contigui, hypostoma breviusculum, medio carinatum utrinque explentes. *Palpi* biarticulati, brevissimi, conici, depressi, apice minute hamulati, in mare labia lateralia haustelli formantes.

Lingua rotundata, mollis, pulvinata, nuda, fissa, lobis introrsum arcte contiguis, crasse marginatis, rimam suctoriam includentibus.

14. The fulness of the vegetative life in fishes expresses itself through the rich variety and size of their external parasites in comparison with the higher vertebrates. Amongst these parasites the Cymothoæ occupy a prominent place. Their stomach (Rathke, *l. c.* tab. vi. figs. 16*b* & 17*b*) is so large that when distended it almost fills the five last segments of the trunk (corresponding to the abdomen in Insects). Its contents are by the action of spirit of wine converted into a tough mass, which may be cut with a knife, and under the microscope shows a plentiful admixture of epithelial cells, in *Æga* sometimes also of blood-corpuscles. This lump when dried is easily taken out whole, particularly in *Æga*, and presents then a perfect cast of the interior of the stomach, in the shape of an oval bean, with a shining smooth surface; along the under surface a groove is observed, indicating the place where the stomach has pressed against the ventral cord of the nervous system; the colour is a light or dark amber, in *Æga* often dark brownish red. These animals have of course been well known to the cod-fishing inhabitants of the north from time immemorial; and the singular fact just alluded to has given rise to curious superstitions amongst the people, and not less curious mistakes on the part of the naturalists of former days. Whilst the fishermen regarded this "stone" as a powerful talisman, securing to its possessor, when rightly used, the fulfilment of his wishes, the medical men recommended it as an infallible remedy against sea-sickness amongst other things; and whilst some naturalists thought that it took the place of the internal organs altogether, others thought it to be the ovary, and O. Fabricius (Fauna Grœnl. p. 250, *Oniscus psora*) thought that it surrounded the intestine.

15. When leaving the pouch the young of *Cymothoa cæstrum* have a sharp-edged forehead, well developed, oval, prominent black eyes, slender, setiform antennæ, the posterior pair so long that they reach as far as the middle of the tail, and slender limbs with long claws, which are hooked only at the point, and which, on those three pairs of legs which are directed forwards, assume the form of saws, owing to a row of powerful teeth on the underside. The tail is entirely free, not much shorter than the trunk, conical, its rings being very freely moveable. Its limbs possess long downy swimming-bristles; the last pair are almost as long as the first five rings of the tail, and point straight backwards, their branches being elongated, narrow, with long downy swimming-hairs at the end. The seventh pair of limbs are wanting as in other newborn young of Isopoda.

According to the classification hitherto current, these young Crustacea would rather be allied to *Cirolana* than to *Cymothoa*; but the facts demonstrated in the foregoing investigation needed scarcely this addition in order to prove that here, too, in our attempts at system we go astray in darkness when we neglect the light afforded by the structure of the mouth. If the young of *Cymothoa*, in the form of body, antennæ, and legs, more reminds one of *Cirolana* than of the adult *Cymothoa*, and if an *Æga* has less external similarity to *Cymothoa* than to *Cirolana*, then all these similarities belong entirely to the class of biological modifications, and are without any typical character at all. It is by marks of distinction of the same kind that *Bopyri* have been separated from the other Isopoda; but as their mouth is of the same construction as in *Cymothoa*, only far more reduced, they ought to be united with *Cymothoa*, *Æga*, and their related genera into one natural family—Cymothoæ. Not even in the characters of distinction now in use are transitions wanting; for there exist twisted species (not yet described) of the family of Cymothoæ, according to the definition of the family hitherto accepted, but which lack the last pair of caudal limbs. Upon the whole we may observe a striking parallelism between this present series of parasites on the one side and Siphonostomata on the other side, although it is not so extensive nor descends so low as the latter, at least according to our present knowledge. *Æga* corresponds to *Caligus*, *Cymothoa* to *Lernanthropus*, *Bopyrus* to *Chondracanthus*. It is the greater or smaller degree of locomotion which decides the shape of the frontal margin. In those parasites which are continually fixed it is blunted; in those which move about it is sharpened by the addition of the basal joint of the first pair of antennæ. In *Æga* these antennæ are still tolerably free, but

joined by a notch and ledge to the second pair of antennæ, and, together with the latter, joined to the eye-margins, whereby a kind of imperfect sucking-cup is formed. In Caligini, on the other hand, the basal joint of the first pair of antennæ coalesces with the sucking-cup, now developing a pair of independent small suckers (*Caligus*), and now forming the so-called lamina frontalis. A vestige of the true front plate is, however, sometimes to be observed, namely the scar indicating the place of insertion of the detached organ of fixation.

EXPLANATION OF PLATE I.

Fig. 1. Head of *Spharoma balticum*, n., from beneath.

Fig. 2 a. Head of *Serolis Orbignyana*, M.-E., from beneath: o, sockets of first pair of legs.

Fig. 2 b. Prosternum and sphenoid plate of the same, from beneath, with the lingua and the maxillæ of the first and second pairs on the right side: o, sockets of maxillipeds.

Fig. 3. Head of *Cirolana borealis*, Lilljeb., from beneath.

Fig. 4 a. Head of *Æga psora*, L., from beneath.

Fig. 4 b. The maxillipeds of the same in their connexion with other parts: c, cardo of maxillipeds; s, stem of ditto; p, palpus of ditto.

Fig. 4 c. Right mandible of the same, seen from the inner side: s, the stem; m, the lobe; p, the palp.

Fig. 5. Head of *Anilocra Leachii*, Kr., from beneath.

Fig. 6 a. Head of *Cymothoa æstrum*, E., ♀, from beneath. The maxillipeds are removed and the sucking-orifice distended: o, sockets of the maxillipeds.

Fig. 6 b. Right mandible of the same, from the inner side: s, stem; m, lobe; p, palpus.

In all the figures, where no other interpretation is given, the following is the signification of the letters:—f, forehead; a, antennæ of the first pair; a*, antennæ of the second pair; c, clypeus; l, labrum; l*, lingua; m, mandibles; x, first pair of maxillæ; x*, second pair of maxillæ; px, maxillipeds; h, sphenoid plate; s, prosternum;

II.—*Notulæ Lichenologicæ*. No. XIX.

By the Rev. W. A. LEIGHTON, B.A., F.L.S.

As Dr. Th. M. Fries's 'Lichenes Spitzbergenses' will in all probability be in the hands of few persons in this country, and as there is a possibility that some of his new species may occur in the northernmost portions of Great Britain, we here extract his descriptions of them.

1. *Lecanora coriacea*, Th. M. Fr.

Crusta crassa, contigua, torulosa l. verrucosa, luteo-albida (l. in roseum vergente), subnitida. K imbuta primum fulvescente, dein sanguinea; apotheciis non visis.

Supra muscos et terram nudam.

Spermogonia numerosa, quorum ostiola nigricantia habitum *Pertusariae* cujusdam huic tribuunt. Spermatia acicularia, recta, sterigmatibus simplicibus adfixa.

2. *Gyrophora discolor*, Th. M. Fr.

Thallo crasso, rigido, usque ad 2-3 unc. diam. lato, superne costis rugisque elevatis valde inaequali scrobiculatoque, toto areolato-rimuloso l. verruculoso, cinereo, subtus aterrimo, fuligineo-pulverulento (rarius centro l. margine pallidiore); apotheciis elevatis, simplicibus, margine cinctis.

Affinitatem cum *G. anthracina* ostendit, praecipue cum *β. tessellata*. CaCl nunc distinctius, nunc obsoletius stratum gonidiale (vel hujus partes sparsas) rubrefacit, qui color mox disparet. Partes apothecii internae congenerum similes; sporae oblongae. Iodo dilute caerulescit, dein sordide decoloratur.

3. *Lecidea conjungens*, Th. M. Fr.

Thallo bullato-verrucoso, sordide cinereo; apotheciis adnatis, majusculis (magnit. *L. vesicularis*), planis, constanter tenuiter marginatis, demum varie flexuosis auriculatisque, nigris, nudis; hypothecio fusco-nigro; paraphysibus filiformibus, laxe cohaerentibus, apice fuligineo-capitatis; sporis in ascis clavatis, 8^{nis}, utrinque obtusis, praeterea valde variantibus, nunc oblongis l. ellipsoideis, diblastis, nunc elongatis l. subcylindricis, tetrablastis.

Ad rupes calcareas.

A *L. vesiculari* sporis, paraphysibus &c. differt; a *L. fusispora*, Hepp., thallo, apothecio, paraphysibus &c. Gelatina hymenea praecedente caerulescentia levi vinose rubet.

4. *Lecidea collodea*, Th. M. Fr.

Crusta tenui, subgelatinosa, cinerascens; apotheciis adnatis, cartilagineis, convexis, dein subglobosis l. varie tuberculatis, siccis nigricantibus, humidis obscure cinnamomeis, quasi pellucidis, nitidulis; hypothecio incolorato; paraphysibus concretis, subhyalinis, apice fuscis l. fuscidulis; sporis in ascis anguste clavatis 8^{nis}, oblongis, simplicibus.

Ad saxa.

Apotheciorum insigni habitu facile distincta species. Iodo circa ascos dilute caerulescit, praeterea sordide lutescit.

5. *Lecidea pullulans*, Th. M. Fr.

Crusta tenui, rimosa, cinerascens; apotheciis minutissimis, numerosis, primo urceolatis, dein planis leviterque convexis,

marginē tenui demum evanescente, nigris; hypothecio incolorato; paraphysibus apicem versus cærulescente-smaragdulis, filamenta in gelatina copiosa referentibus; sporis in ascis clavatis 8^{nis}, oblongis.

Ad rupes micaceas.

Habitus characteresque cogunt hanc pro distincta habere specie; inter species antea descriptas nullam invenimus, ad quam referri possit. Stratum medullare iodo non vel passim dilutissime violascit, hymenium vero cæruleo tingitur colore.

6. *Lecidea scrobiculata*, Th. M. Fr.

Crusta crassa (usque ad .5 millim.) varie rimosa, verrucis vulgo tenuiter rimulosis, sordide argillacea; apotheciis varie flexuosis tuberculatisque primo planiusculis et marginatis, dein subglobosis immarginatisque; sporis globosis l. globoso-ellipsoideis.

Supra rupes.

Habitu a *L. elata*, Schær. adeo recedit, ut primo obtutu pro distincta specie haberes; accuratius examinatæ nexum perspicere tamen crediderimus cum *L. elata*, ad quam sese habet, ut *L. (Sporostatia) tenuirimata* (quacum mixta occurrit) ad *L. (Sp.) Morionem*. Thalli verrucis elevatis interdum adnascuntur apothecia, ut quasi pedicellata appareant. Partes apothecii internæ cum *L. elatæ* congruunt, præterquam quod sporæ vulgo sunt globosæ. Spermatia acicularia recta l. leviter curvata.

7. *Lecidea impavida*, Th. M. Fr.

Thallo minute verrucoso, nigricante vel obscure badio, subnitido; hypothallo nigro; apotheciis minutis persistenter subplanis et margine elevato cinctis, nigris, nudis; hypothecio obscure fusco; paraphysibus omnino concretis, indistinctis, apice fuscis; ascis inflato-clavatis; sporis 8^{nis}, ellipsoideis l. globoso-ellipsoideis. Gelatina hymenea præcedente cærulescentia levi (circa ascos intensiore) fulvescente.

Ad rupes.

Tam externis quam internis notis facillime distincta species. Apud nos hactenus falso omnino pro *L. Mosigii* habita est. Iodo thallus non tingitur, præterquam quod membranæ gonidiorum plus minus distincte violascunt.

8. *Lecidea associata*, Th. M. Fr.

Parasitica, thallo proprio nullo; apotheciis minutis, primo innatis prorumpentibusque, concavis, dein adpressis, planis,

marginē obsoleto l. pertenui, disco ruguloso, atro, nudo; hypothecio incolorato; paraphysibus validiusculis, articulatis, gelatina copiosa imbutis, apice fuscescentibus; sporis in ascis clavato-cylindricis, 8^{nis}, una serie dispositis, breviter ellipsoideis l. subglobosis. Gelatina hymenea iodo vix mutata.

Supra thallum *Lecanora tartarea*.

Statione, apotheciis, ascis sporisque ab omnibus facillime dignota. Ad fungos facillime rejicienda.

9. *Lecidea (Sporostatia) tenuirimata*, Th. M. Fr.

Thallo pallidiore (quam *L. Morio*), ferrugineo- l. flavo-cinereo, protothallo nigro inter areolas distincto; areolis tenuissime rimulosis.

Ad rupes.

Habitus diversissimum atque valde insignem præ se fert, neque dubitarem pro distincta specie eam enuntiare, nisi in ambitu radiante passim adessent areolæ lævigatæ. Nordenskjöld legit specimen has formas aperte jungens. Partes internæ non discrepant.

10. *Lecidea (Buellia) vilis*, Th. M. Fr.

Crusta tenuissima, cinerascens, l. nulla; apotheciis tenuibus, mediocribus, persistenter planis et margine tenui cinctis, nigris, nudis; hypothecio incolorato; paraphysibus capillaribus, conglutinatiss, fuligineo-capitatis; sporis in ascis clavatis, 8^{nis}, diblastis, plus minus late ellipsoideis, utrinque obtusis, fusco-nigricantibus.

Ad saxa.

Habitu ignobilis, facile prætervisa. Apotheciis planis, sporis majoribus, hypothecio incolorato a *L. punctata* Flk. var. *stigmatea* diversa; a *L. leptocline*, cui maxime affinis, omnibusque aliis Buelliis nobis cognitis hypothecio diversa. Apothecia nunc sparsa, nunc conferta mutuaque pressione vario modo angulosa. Iodo hymenio addito, primum cærulescit, dein sordide decoloratur, ascis rubentibus; pars eorum superior tamen haud raro cæruleum servat colorem.

11. *Arthonia (Coniangium) excentrica*, Th. M. Fr.

Thallo crasso, e verrucis contexto verruculosus l. farinaceo-dehiscentibus, albo; apotheciis minutis, adnatis, primo orbicularibus leviterque convexis, dein nonnihil angulosis et planiusculis, scabriusculis, nigricantibus; hypothecio rufidulo-fusco; ascis pyriformibus; paraphysibus gelatinoso-confluentibus, sordide fusciculis, apice fuliginosis; sporis 8^{nis},

cuneato-oblongis, utrinque obtusis, diblastis, hyalinis. Gelatina hymenea iodo intense rubente.

Supra muscos.

Crusta crassa, quæ re vera non aliena videtur, facile distincta species; apotheciorum interna structura excepto paraphysium colore, cum *A. circinata* Th. Fr. satis congruit.

12. *Verrucaria extrema*, Th. M. Fr.

Crusta crassa, inæquali, rimoso-areolata, areolis e granulis minutis congestis contextis, fuliginea l. obscure fusca l. nigricante; apotheciis semi- l. subliberis, majoribus interdum leviter papillatis l. umbilicatis; perithecio nigro; sporis in ascis subcylindrico-clavatis, 8^{alis}, oblongis l. fusiformibus.

In saxis graniticis.

Optime distincta species, thallum si respicis, *Buelliam conio-pem* sat referens; obiter inspecta *Staurothelen Clopinam* in memoriam quoque revocat. Gonidia parva. In perithecio sub microscopio vulgo observatur magna guttarum oleosarum copia. Iodo gelatina hymenea dilute rubet, sporæ fulvescunt.

13. *Verrucaria rejecta*, Th. M. Fr.

Crusta tenui, effusa, l. maculas minutas formante, inæquali, e verrucis minutissimis contexta, sordide nigricante l. cinereo-fusca; hypothallo sordide cinereo-nigricante; apotheciis minutis, globosis, semiliberis l. adnatis; perithecio nigro; sporis in ascis inflato-clavatis, 8^{alis}, ellipsoideis.

In rupibus calcareis.

Inviti, sane hanc novam speciem, habitu ignobilem, proponimus; frustra autem cum aliqua hactenus nobis cognita conjungere conati sumus. Crusta vulgo formatur ex hypothallo ambitu nonnihil radiante et granulis minutis dispersis, obscurius coloratis; ubi paulo crassior, insuper tenuiter rimosa conspicitur. Gelatina hymenea iodo vinose rubet.

14. *Verrucaria (Arthopyrenia) conspurcans*, Th. M. Fr.

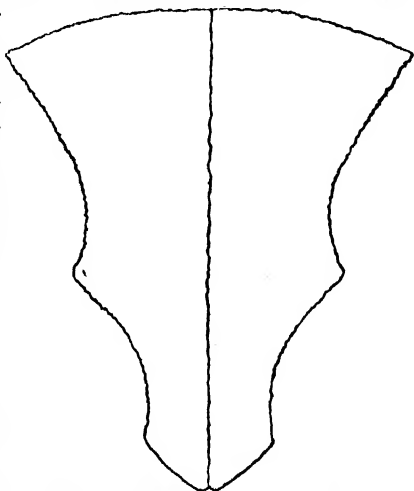
Parasitica, thallo proprio nullo; apotheciis minutis, punctiformibus, adnatis, conico-globosis, atris; ascis ventricosis, paraphysibus gelatinoso-difflexis; sporis 8^{alis}, cuneatis, utrinque obtusis, diblastis, incoloratis.

Supra squamas *L. (Psoræ) rubiformis*.

Iodo ascorum contentus fulvescit, ceterum non mutatur.

III.—*Note on the Phascolomys setosus (Gray) and P. niger (Gould).* By Prof. M'Coy.

THE interesting paper on the species of *Phascolomys* by Dr. Murie in the 'Zoological Proceedings' for December 1865 leaves the *Phascolomys setosus* (Gray) in doubt as a probable variety of the common brown *P. platyrhinus*. I have lately obtained a good skin, from South Australia, agreeing with the original external characters of Dr. Gray's *P. setosus*, and I am glad to find that an examination of the skull shows it to be a well-marked and distinct species. I subjoin an accurate outline (natural size) of the nasal bones, which may be compared with the figures of the three other species in Dr. Murie's paper. It will be seen that, in the great width and flatness of the posterior margin of the nasals, the *P. setosus* approaches the *P. latifrons*, being intermediate between it and the common *P. platyrhinus*, but differing from both in the broad double curve of each side forming a salient angle a little in front of the middle of each side.



Outline (nat. size) of the nasal bones of *P. setosus* (Gray).

I also procured lately an adult male and female and young of the *P. niger* of Gould from Yea, in this colony. The female and young were quite black; and the skulls of each of them showed a small semicircular lobe projecting outwards from about the anterior third of each outer margin of the nasal bones (not to be confounded with the more posterior wide angulation produced by the double concave curvature of the outer margins of *P. setosus*); so that, taken with the difference of colour, I at first thought it possible the species might be really distinct from the *P. platyrhinus*. But on carefully comparing all the bones of the skeleton, I could find no other difference; and on getting the skeleton of the male specimen prepared, I found that its skull agreed with the ordinary type of the *P. platyrhinus* in its nasal bones, although the individual was the mate of the female referred to. The colour was not so perfect a black as in the female and young, but had a brownish tinge;

so that the skull, skeleton, and external characters of the fur showed *P. niger* to be only a variety of *P. platyrhinus*, as Dr. Murie has already correctly surmised would be found to be the case. I finally have just had a typical brown ordinary *P. platyrhinus* prepared for the Melbourne Museum, and have found in it the small lateral lobes on the outer margin of the anterior third of the nasals, which I first noticed in the so-called *P. niger*, and of which there was no trace in five skulls previously prepared; so that there can no longer be the least doubt of the black and brown individuals being only varieties of one species. With the *P. setosus*, we have thus four well-marked living wombats, and at least two fossil extinct ones.

While referring to Dr. Murie's paper above quoted, I may take the opportunity to remark, in reply to his observation that, in my description of *P. lutifrons* published by Mr. Gould, I did not lay sufficient stress on the peculiarity of the softness of the fur, that I have there contrasted it with the coarse hair of the common wombat in the strongest manner, by comparing it to the fur of the English wild rabbit in this respect.

Melbourne, Oct. 26, 1867.

IV.—*Note on the Existence of Gigantic Sea-Anemones in the China Sea, containing within them quasi-parasitic Fish.*
By Dr. C. COLLINGWOOD.

THE most remarkable circumstance which I met with when wading upon a submerged reef in the China Sea was the discovery of some Actiniæ of enormous size, and of habits no less novel than striking. I observed in a shallow spot a beautiful large convoluted mass, of a deep blue colour, which, situated as it was in the midst of magnificent corals of every colour of the rainbow, I supposed also to be a coral; but its singular aspect induced me to feel it, when the peculiar tenacious touch of a sea-anemone made me rapidly withdraw my hand, to which adhered some shreds of its blue tentacles. I then perceived that it was an immense Actinia, which when expanded measured fully 2 feet in diameter. The tentacles were small, simple, and very numerous, of a deep blue colour; and the margin of the tentacular ridge was broad and rounded, and folded in thick convolutions concealing the entrance to the digestive cavity.

While I was standing breast-high in the water, admiring this splendid specimen, I noticed a very beautiful little fish, which hovered in the water close by, and nearly over, the Anemone. The little fish was 6 inches long, the head bright

orange, and the body vertically banded with broad rings of opaque white and orange alternately, three bands of each. As the fish remained stationary, and did not appear to be alarmed at my movements, I made ineffectual attempts to catch him; he always eluded my efforts, not darting away, however, as I expected he would, but always returning to the same spot. Wandering about in search of shells and animals, I returned from time to time to the great Anemone, and each time I found the fish there, in spite of all my disturbance of it. This singular persistence of the fish in keeping to the same spot, and to the close vicinity of the great Anemone, aroused in me strong suspicions of the existence of some connexion between them.

These suspicions were subsequently verified; for on the reefs of Pulo Pappan, near the island of Labuan, I met with more than one specimen of this gigantic Actinia, and the fish, so unmistakeable in its appearance when once seen, again in its neighbourhood. Raking about with a stick in the body of the Anemone, I by degrees dislodged six fishes of the same species, and of various sizes, from the cavity of the zoophyte; and this time, being provided with a hand net, I had no difficulty in capturing them all. Thus the connexion existing between the fish and the Anemone was demonstrated, though what is the nature and object of that connexion remains to be proved.

There are at least two species of these Anemone-inhabiting fish; and a second species of the same genus differs from that just described in having black and cream-coloured vertical bands, instead of orange and white. Such a fish I have seen, evidently closely related to the first described, in the possession of Mr. Hugh Low, of Labuan, who in times past had made many excursions to the reefs, and had become acquainted with this fact. Mr. Low had it then living in a tub which did duty as an aquarium, having obtained it some months before from the body of what was probably a second species of fish-sheltering Anemone. The fish was remarkably lively and knowing, and lived in good health in the tub for several months—a proof that the connexion between these animals, whatever its nature, is not absolutely essential, for the fish at least.

It has long been known that there is a *Holothuria* (*H. ananas*) which harbours a parasitic fish. The *Holothuria* and its fish are figured in the 'Voyage of the *Astrolabe*;' and such a *Holothuria* inhabits the reefs about Labuan; but its fish bears no resemblance to those I have described, not indeed belonging to the same piscine family.

But the saddest part remains to be told. The six fishes having been secured as above, I made no drawing or description of them, but placed them in spirits and transmitted them home with other specimens. From some fault probably in the spirits, these fishes were totally destroyed before arriving in England, although, with the exception of some other fishes, the rest of the specimens were in tolerable order. I trust, however, that, as I know precisely where they are to be found, I shall be able to procure new specimens from the same spot.

V.—On the Irritability of Plants. By C. BLONDEAU*.

WE have undertaken, in the course of the present year, a great number of experiments upon the irritability of plants; and these have shown us that the faculty possessed by certain plants, especially the Sensitive Plant, of executing apparently voluntary movements, may be suspended by various agents, such as ether, chloroform, carbonic oxide, protoxide of nitrogen, and essence of turpentine, all of which, as is well known, act upon the nervous system of animals.

Amongst these experiments there is one which seems to us to possess sufficient interest to induce us to submit it to the judgment of the Academy of Sciences. This consists in submitting the Sensitive Plant (*Mimosa pudica*) to the action of the galvanic current.

In performing our experiments we selected four fully developed Sensitive Plants, the sensibility of which was so great that the least contact, such as the friction of a fly's wing, was sufficient to cause their leaflets to close, and even to depress the petiole of the leaf along the stem. After placing the pots in which these plants had been grown upon an insulating support formed by a plate of glass, we attached to the two extremities of the stem in each of them a small copper wire for the purpose of passing the current generated by a single Bunsen's couple. After waiting for a few moments, the plant reopened its leaflets, and the petiole was raised; the current was then passed, care being taken to avoid any movement which could agitate the plant. Under these conditions we observed no effect, the leaflets did not fold up, the petioles did not lower themselves, and the plant seemed to be insensible to the action of electricity.

We then varied the experiment: instead of employing the direct current of the pile, we made use of the induction-

* Translated from the 'Comptes Rendus,' August 12, 1867, pp. 304-306. *Ann. & Mag. N. Hist.* Ser. 4. Vol. i.

current produced by means of a very small Ruhmkorff's coil. The results were then quite different. Scarcely had the current begun to pass, when the leaflets were seen to apply themselves to one another, then the petioles were depressed along the stem, and the movement was rapidly propagated from one end of the plant to the other. According to this result, the plant is sensitive to electrical disturbances, and behaves in this respect exactly like animals.

We wished to ascertain whether the subjection of the plant to electricity for a longer or shorter time would produce in it phenomena worthy of notice; and with this view we caused the induction-current to act upon three of our Sensitive Plants during different periods of time. The first plant submitted to experiment received for five minutes the disturbances produced by the Ruhmkorff's coil, and at the end of this time it was left to itself. For more than a quarter of an hour the plant remained in the state of prostration to which it had been reduced by the electrical action; but by degrees the leaflets opened, and the stalks raised themselves again, and in about an hour the plant had regained its original position, and did not appear to have suffered in the least by the shocks to which it had been subjected.

A second Sensitive Plant was subjected to the same treatment, but continued for ten minutes. At the end of this time the induction-current which traversed the stem was suspended and the plant left to itself. The Sensitive Plant remained in the state of prostration to which it had been brought by the action of the current for more than an hour, and it was only after this lapse of time that the leaflets began to open and the petioles to elevate themselves. This movement moreover took place more slowly and laboriously than in the preceding case. Evidently the plant had been fatigued; for it did not return to its original position until two hours and a half after the current had ceased to traverse it.

Our third Sensitive Plant was subjected to the action of the induced current for five-and-twenty minutes, and then the plant was left to itself. In this case we waited in vain for it to resume its original position: the prolonged electrical action had been sufficient to destroy all irritability, and even to cause the plant to perish; for on the following day we found our Sensitive Plant withered, and even blackened as if it had been struck by lightning.

Our fourth Sensitive Plant was reserved for an experiment which has proved to us that electrical disturbance acts upon plants in the same way as upon animals.

We know that man, as well as the other animals, when sub-

jected to the anæsthetic action of ether, becomes insensible to the disturbances produced by induction-currents, even when these are very powerful. We wished to see whether this would be the case with the Sensitive Plant.

For this purpose we placed our plant under a bell-glass with two tubulatures, through which penetrated the copper wires serving to pass the induction current through the plant. A few drops of ether were poured into the interior of the bell-glass, and in a short time the plant had undergone the anæsthetic effects of the liquid; for, when shaken, it no longer closed its leaflets or manifested any sensibility. In this state we subjected it to the action of the induction-current; and then it gave no sign of sensibility: the petioles remained straight and the leaflets continued open.

These fresh experiments harmonize with all those which have been made upon this subject, and furnish an argument in favour of the opinion of those who think that the movements observed in these plants are effected by the intermediation of organs analogous to those possessed by animals.

VI.—*Revision of the Species of Hyrax, founded on the Specimens in the British Museum.* By Dr. J. E. GRAY, F.R.S., V.P.Z.S.

THE species of the *Hyraces* are well marked both externally and anatomically; but there is great confusion as to the names that have been given to them in the systematic catalogues.

Prosper Alpinus, in his list of animals of Egypt and Arabia, indicated a species of *Hyrax* under the name of *Agnus filiorum Israël*, which Shaw regarded as a large *Jerboa*; but Bruce corrected this error in his account of the *Ashkoko*.

Pallas described and figured the Cape species under the name of *Cavia capensis*, and Buffon as the *Marmotte du Cap*. It is well known to naturalists as *Hyrax capensis*.

Bruce notices a *Hyrax* under the name of *Ashkoko*, which he described as coloured like a wild rabbit, with scattered black bristles and white beneath. This well agrees with a *Hyrax*, now found in Abyssinia, Dongola, and Upper Egypt, which is in the British Museum. Bruce states that the animal is also found in Mount Lebanon and Arabia Petrea.

Schreber, who only knew the animal from Bruce's figure and description, applied to it the scientific name of *Hyrax syriacus*. The Asiatic species is very like the African; but believe it is distinct; and in that case Schreber's name is

not applicable to the African animal to which Bruce gave the name of *Ashkoko* ("coloured like a wild rabbit, and white beneath"), and which has a yellow dorsal streak. Capt. Harris, who collected animals in Abyssinia, sent home several specimens of a large blackish *Hyrax* having a large black dorsal spot and grey beneath, which he says is called *Ashkoko* by the natives; but it can scarcely be the *Ashkoko* of Bruce, as it does not agree with either his description or figure: perhaps this name is generic. *Hyrax* is also called *Gike* in Abyssinia, according to Salt.

Mr. Tristram informs us that the *Hyrax* in Palestine and Sinai is called *Weber*, and *Thofun* in Southern Arabia. Bruce evidently confounds these *Hyraces* together as one species.

Several zoologists have doubted whether the *Ashkoko* of Bruce was distinct from *Hyrax capensis*: no one can doubt the fact who compares the two. But the large blackish animal which is also found in Abyssinia, and called by the same name as Bruce applies to his species, is so like the *H. capensis* that it would be doubtful if it is a distinct species, if there were not such a difference in the skull. Hemprich and Ehrenberg regard it as distinct, and call it *H. habessinicus*.

Hemprich and Ehrenberg, in the 'Symbolæ Physicæ,' described and characterized by their colours and osteological characters four species of *Hyrax*, viz.:—1. *H. capensis*, 2. *H. syriacus* vel *sinaiticus*, 3. *H. habessinicus*, 4. *H. ruficeps* vel *dongolicus*. They figure three; for the dark animal figured with *H. syriacus* represents a young *Hyrax habessinicus*.

There is no specimen in the British Museum that has a red head, although Prof. Ehrenberg called one of his species *H. ruficeps*; but I think that probably he gave that name to the species which we received from Dr. Rüppell as *H. abyssinicus*, and which I believe to be the *Ashkoko* of Bruce.

There are specimens of four distinct species in the British Museum that have a more or less distinct yellow dorsal streak; and there is another, discovered by Dr. Welwitsch. Four came from Africa, and one from Arabia in Asia. They differ from each other in the texture and the general colour of the fur and of the hairs of which it is composed. Most probably two of these are the species with yellow dorsal spots, characterized by Hemprich and Ehrenberg, viz. *Hyrax syriacus* or *sinaiticus* of Asia, and *H. ruficeps* vel *dongolicus* of Africa.

Two of these species have rather harsh rigid hairs.

Three specimens of the first were sent from Upper Egypt by Mr. James Burton. They are larger in size and much paler in colour than the other species of the group, and very slightly punctulated with black. They have the dorsal

streak comparatively slightly marked and of a pale colour, and the fur is short and close. There is a single young specimen, received from a French collector as from Senegal, very like those from Egypt, showing that this species has a very wide distribution in Africa.

The second, of an iron-grey colour, was brought from Angola by Dr. Welwitsch. Dr. Peters names it *H. arboreus*; but it is quite distinct from that species. I have called it *H. Welwitschii*.

The other three species have very soft close fur; and they differ from one another in the colour of the fur and of the separate hairs. The first, which I believe is the *Ashkoko* of Bruce, is very like a wild rabbit in general colour, and is white below; the hairs have a black subterminal band and a yellow tip, which gives the fur a minutely and closely punctulated appearance. The second is somewhat like the former, and also said to come from Abyssinia; but the fur is pale yellow grey, minutely and slightly varied with black hairs, but not punctulated, and the hairs have no subterminal band; and the underside is yellowish. The third, which is the species found in Palestine and Arabia, is of a nearly uniform reddish-yellow colour, and has longer and softer hairs of a nearly uniform colour.

Sir Andrew Smith, in the Trans. Linn. Soc., described a South African species under the name of *H. arboreus*; and Mr. Fraser described a West African species under that of *H. dorsalis*. Both these species are distinguished by having a white dorsal spot. The type specimen described by Mr. Fraser, and a young specimen received from Sir Andrew Smith of his *H. arboreus*, are in the British Museum.

M. Blainville and other French zoologists have confounded the *H. dorsalis* of West Africa with the *H. arboreus* of the Cape, which are most distinct species, as proved by the types in the British Museum. Dr. Peters described the *H. arboreus* as found on the coast of Mozambique and also in the interior at Tete.

The animals with the white dorsal spot have a very different skull and teeth from the other species which have a black or yellow dorsal spot. Sir A. Smith observed the peculiarity of the teeth when he described *H. arboreus*.

The colour-spots on the back consist of the hair that covers the situation of a dorsal gland on the vertebral line, about halfway between the shoulders and the pelvis.

In the species which have the hair yellow or white the streak is generally narrow and linear; in the species in which the spot is black, it is generally broad and diffused. In some

specimens of *H. sinaiticus* the yellow streak is deeper and brighter-coloured than in others. It appears more marked in the younger and smaller specimens in the British Museum than in the larger and older ones; and it is rather indistinct in the two skins which I believe may be *H. ruficeps* from Abyssinia.

Professors Hemprich and Ehrenberg proposed to use the form of the interparietal bone as a distinctive character for the species: thus they described it as large and trigonal in *H. capensis*, small and pentagonal in *H. syriacus*, large and nearly tetragonal in *H. ruficeps*, and large and semiorbicular in *H. habessinicus*.

M. de Blainville, in the 'Ostéographie,' "Onguligrades," figures the hinder part of the skull of three species to show the interparietal bone; he figures it as elongate and subtriangular in *H. syriacus*, large, broad, and roundish four-sided in *H. capensis*, and very broad in *H. ruficeps*. The part figured as the interparietal in the last species is the broad upper edge of the occipital bone.

Dr. G. v. Jaeger, who has several skulls from the Cape, collected by Dr. Ludwig, and from North Africa by Dr. Heuglin, has written an essay to show that the interparietal bone of the same species varies much in form and size; he figures ten varieties of it in *H. capensis* and three in *H. habessinicus*. He seems to have confounded two species under the latter name, for fig. 14 is evidently a *Dendrohyrax*, Dr. Jaeger having mistaken the broad upper edge of the occipital bone for an interparietal: he also figures the interparietal of a species sent from West Africa by Mr. Dieterle, which he names *H. sylvestris*, which is also a *Dendrohyrax*; but the interparietal is of a very different shape from those of the two skulls of the West African *D. dorsalis* in the British Museum.

Dr. Jaeger shows that the interparietal is variable in shape in *Cavia aguti* (Würzb. naturw. Jahresb. 1860, xvi. p. 158, t. 2).

There is considerable difference in the form of the bladebone in the genera *Hyrax* and *Dendrohyrax*. In *Hyrax* (Nos. 724 *b*, 724 *g*, & 724 *h*) it is elongate, half as long again as broad, with a short, broad process at the lower side of the condyle. In *Dendrohyrax* (No. 1142 *b*) the bladebone is broad, irregular, four-fifths as broad as long, with an elongate compressed process on the lower side of the condyle; the lower edge of the bone in *Hyrax* is sloping for half its length, and then nearly straight; in *Dendrohyrax* this edge is arched from the condyle to the end, the broadest part being near the middle of the lower edge (see Cuvier, Oss. Foss. t. 3. f. 1; Blainville,

Ostéog. t. 3). The following are the measurements, in inches and lines :—

	Hyrax, 724 b.		Dendrohyrax, 1142 b.	
Length of upper edge	2	2	1	9
lower edge	2	1	1	7
Width at widest part	1	7	1	6

Skulls with the teeth in change show the milk- and permanent cutting-teeth at the same time, thus having four upper cutting-teeth. A skull with teeth in this state is figured by Cuvier (Oss. Foss. ii. p. 135, t. 2. f. 5).

In most skulls there is a small hole on each side near the back edge of the cutting-teeth, which Cuvier calls the *trous incisifs* (t. 2. f. 2 n); see also Jaeger, Würzb. naturw. Jahresb. 1860, xvi. t. 2. f. 20 c, who regards it as the remainder of a deciduous second cutting-tooth. This pit is less distinct and nearer the base of the cutting-teeth in the skull of *Dendrohyrax*.

Professors Hemprich and Ehrenberg propose as a specific character the length of the feet compared with the tibiae; but this is difficult to observe in dried specimens or in set-up skeletons, as the length of the feet must depend greatly on how the specimens are mounted.

It is the fashion with certain naturalists (as M. Claparède, for example) to find fault with zoologists for describing specimens in museums; but, as far as mammalia are concerned, it is much more difficult to describe them from living specimens; for then one cannot observe their teeth and bones, or compare many specimens with one another, and can rarely have the opportunity of comparing several species at the same time,—all much greater evils than not being able to tell the sex &c. of the specimens contained in museums. I must say that I think the accusation that “museums are a great incubus to science” must have arisen from the naturalist making it taking a very limited view of the subject. Museums may cause some evil (what does not?); but the advantages of a large collection far exceed any evil I have ever experienced or can ever conceive to arise from them.

Fam. Hyracidae.

Nose blunt, without horns. Body covered with hair, with scattered longer bristles; toes rather elongate, blunt, with flat claws. Tail short or none produced. Teeth 34: incisors $\frac{1.1}{2.2}$, canines $\frac{0.0}{0.0}$, premolars $\frac{4.4}{4.4}$, molars $\frac{8.3}{8.3}$.

Hyrax, Hermann *Lipura*, Illiger; *Hyracidae*, Schinz, Syst. Mamm. 338.

The species may be thus arranged:—

- | | |
|------------------------|--|
| 1. HYRAX. | |
| a. Dorsal spot black. | 1. <i>Hyrax capensis</i> . South Africa. |
| b. Dorsal spot yellow. | |
| • Fur harsh | 2. <i>H. Burtonii</i> . North and West Africa. |
| | 3. <i>H. Welwitschii</i> . Angola. |
| •• Fur soft | 4. <i>H. Brucei</i> . Abyssinia. |
| | 5. <i>H. Alpini</i> . Abyssinia? |
| | 6. <i>H. sinaiticus</i> . Sinai. |
| 2. EUHYRAX | 1. <i>E. abyssinicus</i> . Abyssinia. |
| 3. DENDROHYRAX . . . | 1. <i>D. dorsalis</i> . West Africa. |
| | 2. <i>D. arboreus</i> . South Africa, Tete. |
| | 3. <i>D. Blainvillii</i> . (Skull only.) |

These animals form themselves into three very natural groups or genera, according to their skulls and teeth.

1. HYRAX.

Skull with a distinct narrow sagittal crest on hinder part of crown when adult; nose short. Diastema short, not equal in length to the outer sides of the first three premolars; grinders in an arched line; molars large, broad, square, much larger and broader than the compressed premolars, the first one very compressed. Orbit incomplete behind. Lower jaw very broad behind. Bladebone elongate trigonal.

Skull—nose short; forehead flat or rather convex below the orbit; orbit incomplete behind; the lower jaw much dilated behind. The diastema between the canines and the first premolar short, not so long as the outer edges of the first three premolars. Lower cutting-teeth elongate, narrow at the base, broader above, with three lobes; but the lobes are soon worn away, only leaving indistinct grooves on the surface of the teeth. The lobes of the lower cutting-teeth are distinct in the very young animals which have not yet cut their premolars and last grinder. The upper cutting-teeth of the milk series are rounded in front, broad and spatulate at the end; those of the adult series are trigonal, with a strong central keel in front. The grinders form an arched series; the true grinders large, much larger than the rather compressed premolars; the first (permanent) premolar (that is, the second in the series) small, compressed; the first premolar in the upper jaw of the milk series is triangular, with three roots, the two hinder ones being close together.

De Blainville, in the 'Ostéographie,' figures the skeleton and the skull of a species of this genus under the name of *Hyrax syriacus*; but I am not able to determine to which of the four species of this genus it belongs. *H. syriacus* has almost a generic signification.

The skull in the British Museum (725 c) that agrees with De Blainville's figure of the interparietal bone of *H. syriacus* is rather larger and has the front upper premolar rather larger than the skulls of *H. capensis* according with the same distinctive mark, viz. 724 b, 724 c, and 724 d, which were all received from the Zoological Society without skins; and the hinder openings to the nostrils are more contracted in those named *H. capensis* than in *H. syriacus*.

De Blainville (Ostéograph. t. 2) figures the skull of the very young *Hyrax capensis* as having all the four lower cutting-teeth three-lobed. They are so in a young skull so named in the British Museum; but the lobes are much less distinct and narrower than in skulls of the half-grown and adult *H. dorsalis* in the same collection; and the lobes of *H. capensis* evidently wear away much sooner than in the Tree-Hyraces or *Dendrohyrax*.

The skulls named *Hyrax capensis* in the British Museum, are without skins, and therefore cannot be determined with certainty; they differ in the width of the forehead at the hinder edge of the orbits being greater compared with the length of the skull; they differ considerably in the form of the flat space on the crown, even the skulls of adult animals.

No. 725 c (of Gerrard's Catalogue). The front of the crown is triangular, uniting into a very narrow sagittal crest level with a line over the condyles; the teeth are very large, and the palate wide.

No. 724 b. Rather smaller and wider than 725 c, with the teeth equally large and the palate wide; but the crown is flat, wider in front, becoming narrower and continued behind, and forming a smooth space above.

Nos. 724 c and d are smaller than either 725 c or 724 b. The teeth are very large, the nose is narrower and more compressed; and they differ from both the above in the crown being wider and forming a broad band to the occipital crest. In 724 d the crown is only slightly broader in front, and more nearly of the same width throughout its length. In 724 c it is quite as broad behind as in 724 d, but much wider in front.

The interparietal bones of these two skulls are visible; they are nearly four-sided, and the width of the crown, similar to, but not so large as the interparietal bone figured by Blainville (Ostéograph. t. 2) as that of *H. capensis*.

There is the skull of a young animal, with the milk cutting-teeth, developing the second true molar, in the British Museum (724 g), that has the interparietal similar to those of 724 c and d, but considerably larger, though the skull is smaller, like the figure referred to in De Blainville.

The skeleton with a skull (724 e), in the British Museum, of a young animal with milk cutting-teeth, has a subtriangular interparietal, somewhat like that of *H. Burtonii*.

In the British Museum there is the skull and skeleton of a very young animal, received from the Zoological Gardens (No. 724 h), which is peculiar for having a very broad, half-oblong interparietal bone occupying the hinder edge of the crown, with only the narrow upper edge of the occipital bone behind it. The front edge of the interparietal is regularly rounded, and the hinder one straight. The orbit is incomplete. De Blainville figures a skull of a young specimen (Ostéog. t. 2) as *H. capensis* which somewhat resembles this skull. This skull, in the form of the interparietal, agrees with the nearly adult skull of *Dendrohyrax dorsalis* (No. 1142 c); but we have a skull of a very young animal of that genus in the Museum Collection which has the orbit complete and the upper part of the occipital bone dilated. This skull is so distinct from any other in the collection that I propose to designate it provisionally *Hyrax semicircularis*.

The interparietal bone being on the edge of the occipital region of the skull is a character (as well as the incomplete orbit) that separates the skull of *Hyrax* and *Dendrohyrax*, even in the youngest state.

* *Dorsal spot black, well marked.* Africa.

1. *Hyrax capensis*. The Klipdas.

Fur black, minutely punctulated with white, with a black dorsal streak.

Hyrax capensis, Schreb. Säugeth. 920, t. 240; Cuvier, Oss. Foss. ii. 127, 141, t. 1, 2, 3; Gray, List Mam. Brit. Mus. 187; Gerrard, Cat. Bones Brit. Mus. 283; Blainville, Ostéograph. t. 2 (teeth & skull); W. Read, P. Z. S. 1835, p. 18.

Cavia capensis, Pallas, Misc. 34, 35; Spicil. ii. 22. t. 2.

Marmotte du Cap, Buffon, Suppl. iii. 177, t. 29.

Hab. South Africa, Cape of Good Hope. (Dr. Andrew Smith.)

Var. Dorsal streak indistinct.

Cape of Good Hope (Dr. Krauss). Skull and skeleton, B.M.

For anatomy, see Pallas, Miscell. l. c.; Owen, P. Z. S. 1832, p. 202; Martin, P. Z. S. 1835, p. 13; Murie, P. Z. S. 1865, p. 329.

But I am by no means sure that several species may not be confounded under this name; for all the specimens formerly received at the Zoological Gardens were called *H. capensis*.

**** Dorsal streak yellow, linear.**

a. *Fur harsh.*

2. *Hyrax Burtonii*.

Fur rather harsh, pale yellow grey, very slightly punctulated with blackish; dorsal streak small, yellow; the hairs of the back rather rigid, black or dark brown nearly the whole length, with a moderate yellow tip; underside pale yellow; interparietal bone half-ovate, as long as broad.

Hyrax syriacus, Gray, List. Mam. B. M.

H. abyssinicus, Burton, MS. B. M.; Gerrard, Cat. Bones B. M. 284.

Hab. North Africa, Egypt (James Burton, Esq.): three specimens and a skull in B.M. Senegal (Parzudaki): a young specimen in B.M.

The imperfect skull sent by Mr. James Burton from North Africa, with the skins, which I have named *H. Burtonii* (No. 725 *b*), is not quite adult, as the hinder or third upper true molar is not quite developed. It is very like No. 724 *c* in size, form, and in the form of the crown; but the notch left by the interparietal (for it is lost with the hinder part of the skull) shows that that bone was of a half-oval shape, and rather longer than broad, being rather wider but not near so long compared with its width as the interparietal figured as that of *H. syriacus* by De Blainville (*Ostéograph.* t. 2). This skull differs from those numbered 724 *c* and *d* in being higher behind when placed on its upper grinders, and in the forehead being slightly more convex in the middle below the orbit.

3. *Hyrax Welwitschii*.

Fur short, rather harsh, iron-grey-grizzled; hairs of upper part of the back black, with a large white subapical ring; of the sides dirty brown, with a white ring; dorsal streak yellow, moderate.

Hyrax arboreus, Peters, P. Z. S. 1865, p. 401 (not A. Smith).

Hab. Rocky places on the shores of the River Maiomba, in the district of Mossamedes (Welwitsch, l. c.).

The adult skull of *H. Welwitschii*, lent to me by Dr. Welwitsch, differs from all the preceding in being considerably broader in proportion to its length. The nose is compressed, the crown is flat to the occipital ridge, wide in front, and gradually narrowing behind. The interparietal bone (which is partly destroyed by a hole made to extract the brain) is very small and nearly triangular; the teeth are large, and the palate rather narrow, compared with the other skulls. The diastema

is very short, not exceeding the length of the outer side of the first two premolars. The shortness and width of this skull at once separate it from the skulls of all the species of true *Hyrax* that are in the Museum Collection. This species is only known from a flat skin and a skull collected by Dr. Welwitsch and named by Dr. Peters as above.

Dr. Peters, in a note to me, observes, "I probably made a mistake, and the *Hyrax* (Proc. Zool. Soc. 1865, p. 401) with rather harsh and short hair does not belong to *H. arboreus*, Smith. It has, if I am not mistaken, much shorter ears than *H. arboreus*; and therefore I said the *H. arboreus* has much shorter ears than *H. capensis*, which is not the case. Dr. Welwitsch's specimen resembles more the *H. habessinicus* of Ehrenberg in this respect, and may prove to be identical with that species."

I may add that it differs from *H. abyssinicus* in the skull, the short diastema, and the colour and nature of its fur. It is more allied to *H. Burtonii*, but differs in the colour of the fur. It is very difficult to state the size of the ears of the different species from stuffed or dried skins.

Dr. Welwitsch says, "It always differs by its larger size from a second species living in the interior of Angola." I have not seen any specimens from the latter locality.

b. *Fur soft, close.*

4. *Hyrax Brucei*.

Fur soft, close, yellow grey brown, closely and minutely punctulated with black; underside white; dorsal streak distinct, dark reddish yellow; hairs of the back soft, dark grey brown, with a narrow subterminal band and a yellow tip. *Skull*: interparietal bone oblong, longer than broad.

Ashkoko, Bruce's Travels, t.

Daman d'Ieruel, Buffon, Suppl. vi. 276, t. 24 (from Bruce).

Hyrax syriacus, Schreb. Säugth. iv. t. 240. 13 (from Bruce); Blainville, Ostéograph. t. 2 (skull and teeth).

Hyrax abyssinicus, Rüppell, MS. B. M.; Gerrard, Cat. Bones B. M. 284; Burton, MS. B. M.

? *Hyrax ruficeps* vel *dongolanus*, Ehrenberg, Symbolæ Phys. t. 2 (not Blainville).

Hab. Africa, Abyssinia (Dr. Rüppell): type in B.M.
? Dongola (Ehrenberg): adult skull in B.M.

The name of *H. syriacus* cannot be retained for this species, as it does not come from Syria.

Dr. Peters, in a note which he sent to me respecting Ehrenberg's specimen in the Berlin Museum, observes, "His *Hyrax ruficeps* is hardly different from *H. syriacus*." By the second

name which Ehrenberg gives to this species it evidently came from Dongola in Africa; so it can scarcely be the *H. syriacus* of Ehrenberg from Mount Sinai.

5. *Hyrax Alpini*.

Fur very soft, rather long, pale yellowish brown, very slightly washed with blackish; hairs soft, of uniform length, blackish brown, with yellow tips, and a few scattered black hairs: lips, chin, throat, chest, belly, and inner sides of the limbs pale reddish yellow; hairs yellow to the base: crown and cheeks grizzled, with white tips to the hairs; hairs at the outer base of the ears yellow white; dorsal spot small, reddish yellow.

Hab. North Africa, "Abyssinia (Leadbeater)."

There is only a single specimen of this species in the British Museum; it was purchased in 1843, with the skin of a *Capra nubiana*, from Mr. Leadbeater, who said they came from Abyssinia. The special habitat may be doubtful; but there is no doubt they were from North Africa, and probably from the borders of the Nile.

It agrees with the *H. Brucei* of Abyssinia in the softness of the fur, but differs from it in its general colour, not being closely punctulated, and also in the separate hairs not having any indication of the subterminal black band that produces the punctulated appearance of the fur of that species; and the underside of the animal is yellower. It differs also from *H. sinaiticus* in the general colour being much darker and slightly washed with black, and in the dark colour of the hairs.

H. Burtonii, which we received from Mr. James Burton, with specimens of *Capra nubiana*, is at once known from it by the rigid harshness of the fur, as well as by the colour of the hairs.

6. *Hyrax sinaiticus*.

Fur rather long, soft, pale yellow brown; dorsal streak bright yellow; head and front slightly punctulated with whitish; chin, throat, and underside of the body pale reddish grey. "Interparietal bone small, pentagonal" (Ehr.).

Hyrax syriacus vel *sinaiticus*, Hemp. & Ehrenb. Symb. Phys. t. 2, lower front figure (not Schreber).

Coney (*H. syriacus*), Tristram, Nat. Hist. Bible, p. 75 (not figured).

Uabr, Forsk. Fauna, p. 5.

Hab. Asia, Palestine (Tristram): B.M. Arabia, Mount Sinai (Ehrenberg).

There is a young specimen in the British Museum, that was

purchased at a sale with *Capra nubiana*, which appears to belong to this species; it has the same long hair and fur, showing no sign of the punctulation characteristic of the African species with a yellow dorsal spot.

Mr. Tristram gives a good account of the habits and manners of this animal in his interesting 'Natural History of the Bible,' published by the Christian Knowledge Society.

2. EUHYRAX.

Skull with a distinct narrow sagittal crest the whole length of the crown when adult; occipital not dilated above; nose elongate, produced. Diastema elongate, longer than the length of the outer sides of the first three premolars; grinders in a nearly straight series; molars square, larger than the compressed premolars. Orbit incomplete behind.

The skull is very similar to that of *Hyrax syriacus*?, *H. Brucei*, *H. Burtonii*, and *H. capensis* in general form; but the space between the upper cutting-teeth and the first premolar is nearly twice as long as in those species. In the *H. Brucei* it is as long as the length of the outer sides of the first three premolars and the half of the fourth one; in *H. capensis* it is only as long as the outer sides of the first two premolars and one-third of the third one. The grinders are large, the first upper one being compressed as in *H. capensis*; but they are all smaller, compared with the size of the skull, and are placed in a straighter line, than they are in the other skulls of the species named, and the inner sides of them are more nearly parallel, so that the palate is scarcely wider in the middle of the series of grinders than it is at the front and hinder ends of them. Lower jaw dilated behind. The bladebone elongate trigonal like that of *Hyrax*.

I may observe that Mr. Gerrard, in his 'Catalogue of Bones of Mammalia in the British Museum,' has pointed out that there is a distinction in the skeleton between this species and *H. capensis*. He states that the specimen 724 *a*, in his Catalogue, "has twenty-two pairs of ribs, the first of which are articulated to the last cervical vertebra, and five sternal bones," the *H. capensis*, 724 *b*, in the same collection having only twenty-one pairs of ribs and seven sternal bones. (See Cat. Bones, p. 283.)

It is well worthy of observation that all these osteological characters exist in two species scarcely to be distinguished by their skins. The skull of *Euhyrax abyssinicus* is intermediate between *Hyrax* and *Dendrohyrax*, but more allied to *Hyrax*.

Euhyrax abyssinicus.

Fur blackish, minutely punctulated with white, with a black dorsal spot.

Hyrax habessinicus, Hemp. & Ehrenb. Sym. Phys. (specific characters).

Hyrax abyssinicus, Giebel, Mam. 213.

H. syriacus, Hemp. & Ehrenb. Symb. Phys. t. 2 (hinder figures only).

Hab. Abyssinia, Ankober, Dec. 1847 (male and female); called "Ashkoko" (Capt. Cornwallis Harris). B.M.

Ehrenberg describes the interparietal of *H. capensis* as trigonal, and of *H. habessinicus* as semiorbicular, and the space between the canine and grinders of *H. habessinicus* as being longer than in *H. capensis*; he also says that the fur of *H. capensis* is soft, and of *H. habessinicus* more rigid; but I cannot discover any appreciable difference in this respect between the Cape and the Abyssinian species.

The skull of the adult *Euhyrax abyssinicus*, from the Abyssinian skin, is larger than that of any species of *Hyrax*, and nearly as large as that of *Dendrohyrax dorsalis*; it is narrow, and the smooth space on the crown is linear, of nearly equal width from a line on a level with the front of the condyles.

The second skull (from the skeleton No. 724 a) which I believe to belong to this species, has decayed grinders, having been kept in confinement. It is very like the type specimen, but it is rather shorter, and the hinder part of the crown or sagittal crest is narrower. This skull is exceedingly like the skull figured with its skeleton under the name of *Hyrax syriacus* by M. de Blainville (Ostéograph. t. 1 & 2). It differs from the figure a little in the form of the process of the lower jaw in front of the condyle; but in this respect it also differs from the type specimens of *Euhyrax abyssinicus*. In both skulls the upper edge of the occipital bone is narrow, as in *Hyrax*.

Dr. Peters has, since the above was written, sent me the following observations on Professor Ehrenberg's specimen in the Berlin Museum:—" *H. habessinicus* is a very good species, and may prove to be the same as the *H. dorsalis*. There is a figure of a younger specimen in his work 'Symbolæ Physicæ,' Mammalia, pl. 2. f. 2, together with *H. syriacus*. As you will see from the text, the skull is quite different from that of *H. capensis*, *H. syriacus* (*ruficeps*), and *H. arboreus*. The zygomatic arch is lower than on its junction with the zygomatic process of the maxillary bones; but the teeth are small, as in *H. arboreus*. The hair is harsh, black and grey; and the hair of the belly is much shorter, greyish, sometimes yellowish, without soft fur."

"The skull of my specimen from the coast (regarded as *H. arboreus* in the 'Mammalia of Mossambique') agrees pretty well with that of *H. habessinicus* and with another skull sent by Heuglin from Abyssinia. I cannot understand how this species could be confounded with *H. capensis*."

I may add that *H. abyssinicus* cannot be *H. dorsalis*, as the former has a black and the latter a white dorsal spot, which is well marked in both species.

3. DENDROHYRAX.

Skull rather elongate, with a broad flat crown, separating the entire length of the temporal muscle in the adult animal; nose elongate, produced. Diastema elongate, longer than the length of the outer sides of the first three premolars; grinders and premolars in a nearly straight line, and nearly of the same form, the front premolar being only a little smaller. Orbit complete (or incomplete even in a mature skull).

Nose rather produced; forehead flat; temporal muscles moderate, separated in the adult skull by a broad flat crown; the upper edge of the occipital bone thick, broad, forming part of the crown; lower jaw broad, rounded behind. Lower cutting-teeth moderately long, rather contracted at the base; upper edge dilated and divided into three nearly square, rather spathulate lobes. The lower cutting-teeth are rather elongated in the older animal, but never so long and slender at the base as in the true *Hyraxes*. The upper cutting-teeth of the milk series are rounded in front, and obliquely truncated, spathulate at the end. The canine of the adult series is trigonal, with the keel in the front as in the true *Hyraxes*. The diastema between the canine and the first premolar, in the adult skull, is elongate, as long as the outer margin of the three premolars. The grinders form a very slightly arched series. The true grinders moderate, not much larger than the broad square premolars. The first permanent premolar nearly as large as the second one.

The skull of *Dendrohyrax dorsalis* may be known from those of *Hyrax* and *Euhyrax*, in the youngest state, by the large size of the half-oblong interparietal bone, which is nearly twice as wide as long. In the nearly adult skull it occupies the whole space of the hinder part of the crown. The skull of this genus is also peculiar for the upper part of the occipital bone being produced and expanded, and forming the hinder part of the crown, the hinder edge of the flattened part being keeled and sharply produced in the centre.

There is the skull, with only a few teeth, of a very young

animal in the British Museum (No. 724 f) that agrees with the skull just described in having the upper part of the occipital bone broad and forming part of the crown, and in having complete orbits. It also has a very large, broad, transverse interparietal bone, nearly as wide as the convex crown of the skull; but this is four-sided, and twice as wide as high, as if formed of two squares united in the middle; the outer sides of the bone are rather angular in the middle. I suspect this is the young animal of *D. dorsalis*.

a. Orbit complete. *Dendrohyrax*.

1. *Dendrohyrax dorsalis*.

Fur rigid, bristly, blackish; dorsal spot elongate, pure white. Young—fur soft, silky, reddish brown; back with a broad dorsal streak.

Hyrax dorsalis, Fraser, Proc. Zool. Soc. 1852, p. 99; Verreaux, Cat. *H. abyssinicus*, Read, MS. Mus. Zool. Soc.; Gerrard, Cat. Bones B. M. 284 (no. 725 a).

Hyrax arboreus, Blainv. Ostéogr. t. 2, skull and teeth (not A. Smith); Gerrard, Cat. Bones B. M. 284.

Hab. West Africa (Verreaux). Fernando Po (Fraser): B.M. Ashantee (Read).

There are two adult skulls of this species in the British Museum—one obtained from Fernando Po, and the other received from Mr. James Read, who obtained it from the cap of an Ashantee negro. In both the forehead is flat, rather concave between the orbits, and the orbits have a complete bony ring; they both agree exactly with the figure of the skull of *H. arboreus* in De Blainville's 'Ostéographie,' and with the skull without a lower jaw in the British Museum.

There are the skeleton and skull of a young specimen in the British Museum, purchased from Mr. Jamrach; and this skull agrees with the two adult ones in the concavity of the forehead over the orbits and the complete bony rings to the orbits.

2. *Dendrohyrax arboreus*. The Boomdas.

"Fur reddish fulvous, varied with black; sides reddish white mixed with black; underside and inner sides of limbs whitish; with a central white dorsal streak." (A. Smith.) Young—fur very soft, long, abundant, dark black grey, varied with paler grey; lips, chin, throat, underside of body, and inner sides of limbs white. B.M. Skull — ?

Hyrax arboreus, A. Smith, Linn. Trans. xv. p. 468; Peters, Mossamb. 182? (not Blainville); Kirk, P. Z. S. 1864, p. 856?

Hab. South Africa (A. Smith): a young specimen with *Ann. & Mag. N. Hist.* Ser. 4. Vol. i.

milk-canines, South Africa, from Sir Andrew Smith. Mossambique, Tete (Peters, Kirk).

There is no adult specimen of this species in the British Museum; there is a young specimen, with the milk-teeth, received from Sir Andrew Smith, the original describer of the species. It is so different from the young specimen of the West African species received from M. Verreaux, which agrees with the adult tropical species described by Mr. Fraser, in the British Museum Collection, that there can be no doubt that the South and West African species are distinct, though the French zoologists and osteologists have confounded them.

The young specimen is at once known from the young of *D. dorsalis* by the paler colour of the fur, the want of the dark dorsal streak, and the whiteness of the under surface.

Dr. Peters, in his 'Mammalia of Mossambique,' says that *D. arboreus* is the only species of *Hyrax* he found in Mossambique. It occurs near the capital of Mozambique, on the coast, and at Tete in the interior, where it is called *Mbira*.

It would be interesting to know if this is the same as *H. dorsalis*, as the latter occurs at Ashantee.

Common on rocky hillsides, living in colonies. Caught by spring-traps; flesh good to eat (Kirk, P. Z. S. 1864).

Dr. Peters, in a note to me respecting the *Hyraxes* mentioned in his 'Mammalia of Mossambique,' observes, "It may be that there are two species of *Hyrax* in Mossambique—one on the coast, and the other in the interior. From the coast I only got a female specimen: the skull of this species shows small grinders compared with those of *H. syriacus*, and seven in number." See further observations on this skull under *Euhyrax abyssinicus*. "The other specimen from the interior, the Carnera Hills near Tete, agrees perfectly with the *H. arboreus* from the Cape." This species is easily to be distinguished by its soft fur and want of rusty colour; the hairs of the under-side are white, and brownish grey at the base.

b. *Orbit incomplete*. Heterohyrax.

3. *Dendrohyrax Blainvillii*.

An adult skull in the British Museum (No. 724 e), without its lower jaw, was received from the Zoological Society without any habitat or history attached to it. It has small, more equal-sized molars and premolars, in a nearly straight line, and the great length of the diastema which is so characteristic of this section of the genus. It may be the skull of the *D. arboreus* of South Africa. It differs from the skull of *D. dorsalis* in being small, in the forehead being convex in the centre between the orbits, and in the orbits being incomplete behind.

It has the alveoli of the upper cutting-teeth each raised into a cup round the base of the tooth; but this may be only an individual peculiarity.

This skull has all the characters of the genus *Dendrohyrax*, except that the orbit is incomplete behind. I think that it indicates a new group, to which the name *Heterohyrax* may be given. The skull is much smaller and the tooth-line much shorter than in *D. dorsalis*; and I propose to name it provisionally *Heterohyrax Blainvillii*. The skull which M. de Blainville figures as that of *Hyrax rufipes* (Ostéograph. t. 2) exactly represents the hinder part of that in the Museum. It cannot be the *H. ruficeps* of Ehrenberg.

Dr. G. v. Jaeger figured, under the name of *Hyrax habessinicus* (t. 2. f. 14), the upper part of the skull of a *Dendrohyrax* obtained from Gondar by Dr. von Heuglin. Dr. Jaeger, by mistake, figures the upper edge of the occipital for the interparietal. This skull is interesting as showing that the genus is found in Abyssinia.

Dr. G. v. Jaeger also figures the back of the skull and interparietal bone of a species he calls *Hyrax silvestris*, collected in West Africa by the missionary Dieterle. It is probably a *Dendrohyrax*. The hinder part of the figure is the upper edge of the occipital. The interparietal is urn-shaped, broader in front and contracted behind, very unlike that found in the skulls of either of the two species in the British Museum, and especially differing from *D. dorsalis* of West Africa; so it may be a new species of the genus, *Dendrohyrax silvestris* (Würzb. naturw. Jahresb. xvi. p. 162, t. 2. f. 15).

The Measurements of the Skulls, in inches and lines.

	<i>H. abyssinicus</i> , 725 d.	<i>H. abyssinicus</i> , 724 a.	<i>Hyrax</i> , 726 c.	<i>Hyrax</i> , 724 b.	<i>Hyrax</i> , 724 d.	<i>Hyrax</i> , 724 c.	<i>H. Burtoni</i> , 725 b.	<i>H. Walcottii</i> .	<i>Hyrax</i> , 724 g (junior).	<i>H. semicirculatus</i> , 724 A.	<i>D. dorsalis</i> , 1142 a.	<i>D. dorsalis</i> , 1143 c (junior).	<i>D. dorsalis</i> , 724 f.	<i>D. Blainvillii</i> , 724 e.
Length of skull	4 0	3 7	3 6	3 6	3 2	2 11	.....	3 2	2 7½	2 3½	4 0	3 4	2 1	3 4
tooth-line.	1 8	1 4½	1 6	1 6	1 4	1 2	.....	1 8	.....	1 7	.....	.....	1	2½
Width at centre of symosa, of fore- head	2 2½	2 0½	2 0½	2 1	1 9	1 8½	1 8	2 0	1 7	1 3	2 3	1 10	1 2½	1 11
Width at back end of orbit	1 7	1 6	1 6	1 6	1 3	1 3	1 2½	1 6	1 2	1 0	1 9	1 6½	1 0	1 5½
Width of band at middle of crown over condyles ..	0 3	0 2	0 0½	0 6	0 6	0 7	0 6½	0 8	.....	.....	0 9	1 0	.....	0 10
Width of nose	0 7	0 7	0 8	0 7	0 6	0 5½	0 7	0 6½	0 6	0 5	0 8½	0 7	0 5	0 7
" at outer edge of tooth-line, at first molar	1 3	1 2	1 4	1 2	1 1	1 0½	1 0	1 0½	0 10½	0 9	1 2½	1 0	.....	0 11½
Width of palate at first molar	0 7½	0 7½	0 8	0 7	0 6	0 7	0 6½	0 6½	0 6	.....	0 9	0 8	.....	0 6

VII.—On *Globiocephalus Grayi*, *nov. spec.*

By Dr. HERMANN BURMEISTER.

[Plate II. figs. 2 & 3.]

Two months ago the public museum of Buenos Ayres received the skull of a large Dolphin of the subgenus *Globiocephalus*, which seems to belong to an unknown species inhabiting the southern parts of the Atlantic Ocean, as the skull was found on the shore of the State of Buenos Ayres. I venture to describe this new species under the name of my friend Dr. J. E. Gray, who has recently contributed so greatly, by his valuable investigations, to the increase of our knowledge of the Cetacea.

Compared with the skull of *Globiocephalus svineval* s. *melas*, as shown in the figures of this species given by Cuvier (Ossem. Foss. tome i. pl. xxi. fig. 11) and Gray (Catal. p. 316), this skull is somewhat larger in the anterior part of the nose, and not so large in the posterior part between the orbital arch. To show this difference, I here give the measurements of the new species corresponding with those of the European species given by Dr. Gray (*l. c.*):—

	in.	lin.
Entire length of the skull	25	0
Length of the nasal part	13	0
Length of the teeth-series	10	0
Length of under jaw	21	0
Width at notch	12	0
Width at orbit	14	6
Width of intermaxillaries	6	0
Width of middle of nose	8	6
Height of occiput	10	0

As the general form of the exterior of the skull is sufficiently shown by the accompanying figure (Pl. II. fig. 2), I will describe only the differences of its constituent bones. The greatest difference is shown in the form of the tip of the nose, which is much broader and more rounded in *Globiocephalus Grayi* than in *G. svineval*. This difference is combined with a totally different form of the intermaxillary bones, these being short, rounded at the anterior extremity, and then nearly parallel, with the outer margins not diverging posteriorly as in the European species. In the middle these bones, in my new species, are narrower and more excavated at the margin; and at their hinder parts they are rather more curved outwards. The part of the vomer which is visible between the intermaxillaries seems to be somewhat broader, and the small portion of the maxillaries, seen from above at the sides of the

vomer, much shorter. The narrow form of the anterior part of the intermaxillaries allows us to see a considerable portion of the maxillaries on all sides of the tip of the nose; these appear only as a narrow band in the European species. The form of the maxillaries, at their anterior extremity, is also different; they are here broader and shortly rounded, and nearly parallel on the outer margins. The orbital part is not so broad, and the hinder edge of the orbit not so prominent. On the other hand, the cerebral region of the skull is broader, and much more produced behind in my species.

The small surface of the frontal bones seen behind the maxillaries is comparatively broader, and the elevated margin of the parietals which separates the upper surface of the skull from the occipital surface is nearly in a straight line, a little undulated on each side, but by no means curved forwards as in the European species. In the latter the exterior margins of the occipital surface, which are also the hinder margins of the temporal groove, are inclined backward on both sides; but they are perfectly parallel and much more prominent in *G. Grayi*, so that the general form of the occipital surface in this species is rather a plane than a portion of a spherical curve as in the European species. Hence the occipital condyles are more prominent posteriorly in the former and more retracted in the latter.

Beneath, the general configuration of the skull is nearly the same in both species; but a very important difference is to be found in the length of the teeth-series. In the European species this series occupies only half the length of the margin of the maxillary, but in the new Argentine species nearly the whole margin, except only an extent of 2 inches at its hinder extremity. This difference is very remarkable, and is due to the greater size of the teeth, especially the anterior ones. The European species has generally twelve teeth on each side, in some cases fourteen, or, exceptionally, only eleven. My new species has only nine teeth on each side in both jaws; and these are of nearly equal size, except that the first is somewhat smaller: in the European species, the first five teeth are very small, increasing somewhat in size posteriorly; and the seven following ones also are not equal in size, but gradually increasing. All the teeth in *G. Grayi* are nearly of the same form, having a truncated molar surface and a very short prominent crown; more than two-thirds of each tooth is enclosed in the alveolus, terminating below in a conical root which is nearly closed, exhibiting only a very small opening in the middle (Pl. II. fig. 3, a tooth, half the natural size).

The lower jaw is rather strong. Each ramus is 21 inches in length, and 6 inches 4 lines in depth at the well-marked coro-

noid process. The symphysis extends 3 inches 6 lines; and the teeth-series occupies nearly one-half of the upper margin from the tip to the coronoid process, measuring 9 inches 4 lines in length, and the free part of the margin to the extremity of the coronoid process 10 inches.

I know nothing of the other parts of the skeleton.

On my first voyage across the Atlantic, I saw seven *Globiocephali* swimming near the vessel, in 10° N. lat., on the 2nd November, 1850 (see my 'Reise nach Brasilien,' Berlin, 1852, p. 43), and observed them for a long time. I suppose these animals would be of the same species as the one here described; and if so, their whole external appearance is identical with the figure given by Couch (Ann. Mag. Nat. Hist. 1st ser. vol. ix. 1842, pl. 6). But as I did not see the underside of the swimming animal, I cannot say whether this species has the white spot which is characteristic of the European animal.

VIII.—On a new *Volute*. By Prof. M'Coy.

[Plate II. fig. 1.]

Voluta Thatcheri (M'Coy). Pl. II. fig. 1.

Slender, elongate fusiform; greatest width (which is near the middle of the body-whorl) only half the length of the body-whorl; about ten tubercles on the penultimate whorl, slightly below the middle; only about seven on the shoulder of the body-whorl, from their being obsolete near the outer lip. Seven thick plaits on the columella, the two posterior smaller than the rest, which are nearly equal. Colour a white ground, with a row of elongate quadrangular spots on the suture and two broad spiral bands of hieroglyphic markings on the body-whorl, one just below the tubercles and the other near the anterior end; in front of the latter an irregular row of small quadrate spots; all the markings pale yellowish brown ("burnt-sienna" colour); traces of a yellowish reticulation between the bands.

Length of the last three whorls 2 inches 10 lines, width 1 inch 1½ line; length of penultimate and antepenultimate whorls together 6 lines.

I name this beautiful *Volute* after Mr. Charles M. Thatcher, of Melbourne, an enthusiastic and acute conchologist, who perceived the probable novelty of the species from the most obvious characters of the slender form and seven plaits to the pillar—a combination of characters separating it from all others I know. Mr. Thatcher has added the specimen to the National-Museum Collection at Melbourne. The spire is broken.

Habitat unknown.

IX.—On the Nature and Zoological Position of the Graptolitidæ. By HENRY ALLEYNE NICHOLSON, D.Sc., M.B., F.G.S.

[Plate III.]

THE Graptolitidæ constitute a group of extinct organisms which may be considered characteristically Silurian, though one genus (*Dictyonema*) passes up as high as the Middle Old Red in America. Their zoological position has always been a matter of doubt; and they have been referred by different palæontologists to the Cephalopoda, the Hydrozoa, the Actinozoa, the Polyzoa, and recently to the Foraminifera. The first and last of these views require no further notice; but the remaining three are still maintained by different competent authorities, and the question must be looked upon as still undecided. In the following brief description of the morphology, development, and reproduction of the Graptolitidæ I purpose to draw attention to the facts which appear to favour the view, originally put forth by Prof. M'Coy, that the group should be referred to the Hydrozoa.

Morphology.—As to the morphology of the Graptolitidæ, the simplest form of Graptolite is composed of three factors, structurally and developmentally distinct, but united into a single linear stipe. These three elements (Pl. III. fig. 2) are known as the "solid axis," the "common canal," and the "cellules;" and when combined together the solid axis is found as a cylindrical filament, or laminar plate, having on one side of it the common canal, from which, as a common connecting substance, arise the denticulated cellules. In this way are formed those simple forms of Graptolites (Pl. III. fig. 1) to which alone the genus *Graptolites* or *Graptolithus* ought to be restricted; and by the combination of such in various different modes are formed all the remaining generic types of the Graptolitidæ. The simple uniserrate Graptolites thus composed, such as *G. Sedgwickii*, *G. sagittarius*, &c., have certainly no direct representatives amongst either the Hydrozoa or the Polyzoa; but the corneous nature of the entire polypary and the presence of a "common canal" would seem to refer them to the former, since the latter have, as a rule, a more or less calcareous test, and the individuals forming the compound organism are not united by any organized connecting substance. There is, besides, an obvious resemblance between the monoprionidian stipes and the separate branchlets of some of the Plumulariæ, such as *Plumularia pennatula* and *P. cristata*; whilst the diprionidian forms constituting the genus *Diplograpsus* have an equally obvious analogy to the ramuscles of some of the Sertularians, such as *Sertularia abietina* and *S. filicula*.

The "solid axis" is one of the primitive elements in the formation of every Graptolite. In the simple monopronidian species it seems to be a solid cylindrical rod (Pl. III. fig. 2); but in the biserrate forms it is certainly a corneous plate, dividing the frond into two vertical compartments (Pl. III. fig. 3), apparently composed of two laminae, with a median cylindrical rod and perhaps including a central canal. The axis may be prolonged beyond one or both extremities of the celluliferous stipe; and for convenience I shall term these respectively the basal or "proximal" and the terminal or "distal" extensions of the axis. These prolongations (Pl. III. fig. 4) are little understood; but they require especial attention, as throwing great light upon the true nature of the Graptolitidæ. The proximal extension of the axis is present in probably all the true Graptolites, and constitutes the "radicle" or "initial point" of Hall. The radicle varies greatly in length, and it may consist of the solid axis alone, as in *Diplograpsus teretiusculus* &c.; or it may be bordered by the common canal prolonged upwards into the first cellule or cellules, as in *G. sagittarius*, Linn., *Diplograpsus cometa*, Gein., and *D. acuminatus*, Nich.

Again, in most of the branching and complex Graptolites the solid axes of the various simple stipes composing the frond, together probably with the common canal, are prolonged proximally and are united into a connecting process, which is always destitute of cellules and is termed the "funicle" by Hall, as is seen in the genera *Dichograpsus* and *Tetragrapsus* (Pl. III. figs. 5, 6, 15, 16, and 20).

Lastly, the subdivisions of the funicle may be embraced by a central corneous disk or cup, which is apparently composed of two laminae, and probably enclosed a central cavity. This corneous cup (fig. 6) is best seen in several species of *Dichograpsus* and *Tetragrapsus*; but it also exists in some specimens of *Diplograpsus bicornis*, Hall (figs. 8, 9, 10), and in a new species of *Diplograpsus* from the Upper Llandeilo rocks of Dumfriesshire, which I have named *D. physophora* (fig. 7). The distal extension of the solid axis is only seen in the *Diplograpsi*, and possibly in *Retiograpsus*, Hall, and *Retiolites*, Barr., seeming to be merely accidental when seen in the adult monopronidian forms, as it rarely is. This distal extension of the axis usually consists of the solid axis alone, as in all the common *Diplograpsi*; but it may consist of a bladder-like body, more or less elliptical in form, with a distinct filiform margin and of uncertain function. This vesicular dilatation seems always to be a direct expansion of the axis, which would thus appear to be tubular. It is seen to a very moderate extent in some specimens of *D. pristis*, His., and *D. palmeus*,

Barr., but it is very largely developed in a new species of *Diplograpsus* from the Dumfriesshire Shales, which I have named *D. vesiculosus* (Pl. III. fig. 11).

The homologues of the solid axis, with its extensions and appendages, are by no means clear. There is no known structure, either amongst the Hydrozoa or Polyzoa, which could be looked upon as its exact equivalent; and it is probably related (but by analogy only) with the horny or calcareous "sclerobasis" of the Gorgonidæ and Pennatulidæ amongst the Actinozoa. Its chief function certainly seems to have been to give due support to the cœnosarc, and to prevent injurious flexion of the pliable polypary; but it probably subserved other purposes of even greater importance. No close parallel can be drawn between the "radicle" of the Graptolitidæ and the foot-stalk of the Sertularidæ, since the former structure beyond doubt did not serve as an organ of attachment. The central disk or cup of some *Dichograpsi*, *Tetragrapsi*, and *Diplograpsi* was compared by Prof. Huxley with the basal plate of *Defrancia*, a Bryozoon; but I think a more probable homologue is to be found in the "float," or "pneumatocyst," of the Physophoridæ, an order of the oceanic Hydrozoa. The distal extension of the axis is entirely without a parallel; and when dilated, as in *Diplograpsus vesiculosus*, Nich., it is difficult to conceive of any function which it can have subserved. It cannot be of the nature of a float, since it occupies the distal and not the proximal extremity of the organism; and the most probable view would perhaps be to consider it in some way connected with the reproductive process. The second element, namely the "common canal," is structurally a tube extending along more or less of the axis, and giving origin to the cellules. Ordinarily it appears as a flattened space between the cellules and the solid axis (Pl. III. fig. 2); and it seems certainly to be a distinct structure even in those forms in which the cell-partitions are attached to the axis. As to the intimate nature of the common canal, there seems to be no doubt that it conveyed a soft connecting substance uniting the various polypites into an organic whole; and it is therefore homologous with the "cœnosarc" of the Hydrozoa. Its existence consequently forms one of the strongest grounds for eliminating the Graptolitidæ from the Polyzoa, since no analogous structure is known to occur in any of the latter.

Of the cellules there is little to be said. They vary much in shape; but they usually constitute more or less cylindrical or quadrangular tubes, the bases of which are attached to the common canal, whilst the opposite extremities terminate in open mouths—the "cell-apertures." They thus come to re-

seem somewhat the "hydrothecæ" of the *Sertulariæ*; but they are invariably in contact for a greater or less portion of their length, and they do not seem ever to be cut off from the common canal by any partition or diaphragm.

Development.—The ordinary germs or embryonic forms of *Graptolites* (Pl. III. figs. 12, 13), in the youngest condition in which they are preserved to us, are minute corneous bodies, consisting of a small radicle or mucro, which is in fact the commencement of the solid axis. This, the primitive structure of the embryo, is widened out distally by the presence of the common canal on one or both sides, according as the germ belongs to a mono- or to a diprionidian species; and finally one or two primordial cellules are superadded. Even at this stage the solid axis projects beyond the primitive cellules as a naked rod; and its growth was probably carried on to a certain extent independently of the rest of the organism. These germs are various in size, and differ in minor details; but they all possessed a corneous envelope, and they cannot safely be compared to any of the embryonic forms of the existing *Hydrozoa* or *Bryozoa*. It must, in fact, be considered very probable that these germs, as we see them, are considerably advanced in growth, and that the earliest form of the embryo was devoid of any corneous test.

As to the further development of the stipe, it must suffice to state that in the simpler genera the secondary cellules appear to be intercalated between the initial point or radicle and the primordial cellule or cellules, so that the youngest cellules are proximal, the oldest distal in position. This mode of development corresponds with that observed in the *Calycophoridæ* and *Physophoridæ* amongst the *Hydrozoa*.

Reproduction.—Until quite of late years, the reproductive process in the *Graptolitidæ* was quite unknown; and even now our knowledge is partial and to a great extent inferential. In 1858 Prof. Hall gave a description of some specimens of *Diplograpsus Whitfieldii* bearing bodies which he regarded as ovarian vesicles. According to Hall, these appear as small ovate buds attached to the stipe on both sides, enlarging to form elongated sacs, and finally dehiscing. These sacs are limited along their margins by a filiform border like the solid axis of a *Graptolite*; and it appears inconceivable that their function can have been other than reproductive.

At the meeting of the British Association in 1866, I drew attention to the occurrence in the *Graptolitic* rocks of Dumfriesshire of bodies essentially similar to those described by Hall; and I have since described them more fully and have adduced instances in which they are seen attached to

the stipe of *Graptolites Sedgwickii*. These bodies differ from those noticed by Hall in being free in the later stages of their growth, instead of remaining permanently attached. They are oval or bell-shaped, provided with a mucro or spine at one extremity, and surrounded by a strong filiform border, which ultimately ruptures. In many instances these bodies may be seen, when small, to be attached to the cellules of *Graptolites Sedgwickii*; and they appear sometimes to spring from the common canal, though this is rare and is perhaps accidental.

That these bodies are connected in some way with reproduction appears to me to be beyond doubt. They resemble the "gonophores" of the recent Hydrozoa in being external processes, in some cases permanently attached, in others ultimately detached; the likeness in form is also striking. They differ, however, in possessing a corneous envelope, so that, when detached, they were either simple free-floating organisms, or, if they possessed any independent locomotive power of their own, this must have been obtained by means of cilia or by some soft apparatus which would leave no traces of its existence. It is probable that the capsules did not contain the germs of *Graptolites* as we now find them in a fossil condition, as thought by Hall, but that their contents were the ova in their earliest stages. The ova would probably be liberated, on the dehiscence of the capsule, as minute ciliated free-swimming organisms, which subsequently and as a later development acquired a corneous envelope. With regard to other species of *Graptolites*, it may be looked upon as probable that the gonophores, if corneous, were attached to the sides of the polypites or to "gonoblastidia," whilst in other species, again, the gonophores were probably without any corneous test; so that the great majority of species will perhaps never be found in conjunction with ovarian capsules, either free or in connexion with the parent stipe. Judging, however, from analogy, there seem to be good grounds for the belief that the reproductive process in all the Graptolitidæ was in all essential points identical with that of the Hydrozoa.

Mode of Existence. — As to the mode of existence of the Graptolitidæ, there can be no question that by far the greater number were free-floating or free-swimming organisms. In some species of *Dichograpsus*, *Tetragrapsus*, and *Diplograpsus*, there are the remains of a body (the "disk") which, as I have already said, probably acted as a float, and finds its best homologue in the "pneumatocyst" of the Physophoridæ. Other genera, as *Graptolites*, *Phyllograpsus*, *Pleurograpsus*, *Retiolites*, &c., were very possibly provided with "nectocalyces" or "swimming-bells;" but these, of course, could

never be preserved in a fossil condition. With regard to *Dendrograpsus* (Pl. III. figs. 16, 17) and *Callograpsus* (two genera which more closely resemble the Sertulariæ than any other), the probabilities are, perhaps, in favour of their having been fixed, though there is no decided evidence in support of this view; and the same may be said of *Dictyonema*.

Allied forms.—The affinities of *Graptolites* as regards other extinct organisms are few and uncertain. There exists, however, one allied form (Pl. III. fig. 19), which I described last year from the Dumfriesshire Shales under the name of *Corynoides calicularis*. In this the polypidom is in the form of a simple elongated tube, without any central axis, furnished at the base with two spines, and expanding distally into a toothed cup or "hydrotheca." In general form *Corynoides* closely resembles some of the Corynidæ or Tubulariæ; but the "hydrosoma" has certainly been free, and was never fixed by a hydrorhiza." Whether *Corynoides* should be included amongst the Graptolitidæ, or should be regarded as the type of a new order, is doubtful; but it is certainly allied to the Graptolites, and greatly strengthens the belief that the latter belong to the Hydrozoa.

Conclusion.—I have now endeavoured to show that the position of the Graptolitidæ amongst the Hydrozoa is supported by the phenomena observed in their morphology, development, and reproduction, in their mode of existence, and by the determination of allied forms. As to their exact place, it is certain that they cannot be referred to any existing order or even subclass of the Hydrozoa, and it is probable that they stand in the same relation to the recent Hydrozoa that the Trilobites do to the Crustacea. In the arrangement of their parts and in their mode of growth, as well as in the nature of their structural elements, they more or less resemble the Hydroid polypes; but they are widely separated by their free hydrosoma. On the other hand, they approximate to the oceanic Hydrozoa in the fact that they were free-floating organisms, and in the possession, by some forms, of an organ resembling a "float." In the present state of our knowledge it seems, therefore, most advisable that the Graptolitidæ should be held to constitute a new subclass, which will hold an intermediate position between the fixed and oceanic Hydrozoa, and which might possibly, on the derivative theory of development, be considered the primitive stock from which the above existing sections of our living Hydrozoa have originally diverged.

EXPLANATION OF PLATE III.

Fig. 1. *Graptolites sagittarius*, Linn., nat. size: showing the radicle (α).

- Fig. 2. Portion of the same, enlarged: showing the solid axis, the common canal, and the cellules.
- Fig. 3. Transverse section of *Diplograpsus teretiusculus*, His.: showing the axis as a transverse plate or partition.
- Fig. 4. *Diplograpsus teretiusculus*, His., nat. size: showing the proximal extension of the axis, or radicle (a), and the distal extension (b).
- Fig. 5. Central portion of *Dichograpsus Loganii*, Hall, sp., from a specimen collected by the author from the Skiddaw Slates: showing the branched funicle and the celluliferous stipes.
- Fig. 6. Central disk and funicle of *Dichograpsus octobrachiatus*, Hall, sp. One of the divisions of the funicle (a) is shown prolonged into a celluliferous style (b).
- Fig. 7. *Diplograpsus*, n. sp.: showing a disk at the proximal extremity. Collected by the author at Garple Linn, near Moffat.
- Figs. 8, 9, 10. Varieties of *Diplograpsus bicornis*, Hall. Fig. 8. Normal form. Fig. 9. Variety with a rudimentary disk or cup; collected by Prof. Harkness at Glenkiln Burn, Dumfriesshire. Fig. 10. Variety with a fully developed disk, after Hall.
- Fig. 11. *Diplograpsus vesiculosus*, n. sp.: showing the distal extremity of the axis expanded into a pointed vesicle. Collected by the author at Dobb's Linn, near Moffat.
12. Germ of a monopronidial Graptolite, enlarged.
13. Germ of a dipronidial Graptolite, enlarged.
- Fig. 14. *Didymograpsus flaccidus*, Hall, nat. size (recently described by Mr. W. Carruthers under the name of *D. elegans*). This form could obviously never have been attached, but must have been free.
- Fig. 15. *Helicograpsus (Graptolithus) gracilis*, Hall, sp., nat. size: a, funicle; b, b, celluliferous stipes. From a specimen collected by the author at Glenkiln Burn, Dumfriesshire.
- Fig. 16. Non-celluliferous stem, or funicle, of *Dendrograpsus Hallianus*, Prout, after Hall. This species may perhaps have been attached.
- Fig. 17. Portion of the celluliferous branches of the same.
- Fig. 18. *Diplograpsus* resembling *D. teretiusculus*, His., but furnished with two lateral spines in addition to the central radicle.
- Fig. 19. *Corynoides ocellularis*, Nich., enlarged. This form is allied to the Graptolites, but probably represents a different order.
- Fig. 20. *Tetragrapsus quadribachiatus*, Hall, sp.: showing the funicle, radicle, and celluliferous stipes.

X.—On the Miocene Flora of the Polar Regions.

By Professor O. HEER*.

THE numerous expeditions sent some years ago into the arctic regions have been, in every respect, productive in a scientific point of view. The bold navigators who explored the polar regions, surmounting the greatest difficulties, used every effort to bring back whatever they supposed might possess interest. Geology has had its share in the results of these researches. A considerable number of fossil plants

* Translated by W. S. Dallas, F.L.S., from the 'Bibliothèque Universelle,' Archives des Sciences, Nov. 25, 1867, pp. 218-231.

derived from these explorations have been deposited in various museums, amongst others in those of Dublin, London, Copenhagen, and Stockholm. These precious materials have been placed at my disposal; and thus I have been enabled to examine a great quantity of fossil plants found in the north of Canada, near the Mackenzie River, on Banks Land, in North Greenland, in Iceland, and Spitzbergen. The study of these has led me to some important results with regard to the distribution of plants during the epochs preceding that in which we live. I have also been able to draw from them some interesting conclusions as to the climate which was then enjoyed by the countries situated around the North Pole.

The Arctic fossil Flora, in the present state of our knowledge, consists of 162 species. The Cryptogamia include 18 species, 9 of which are fine Ferns of large size, which probably covered the soil of the forests. Among the others we must note some little Fungi, which then formed spots and small points upon the leaves of trees, as the analogous species do at the present day. Among the Phanerogamia we find 31 species of Coniferæ, 14 species of Monocotyledons, and 99 species of Dicotyledons. Judging of these from the allied species in existing nature, 78 of them were trees, and 50 shrubs. Thus, therefore, 128 species of ligneous plants were then diffused over the polar regions. Among the Coniferæ we remark *Epiceæ*, Junipers, and Pines, most of which resemble American species. One of the most remarkable species is the *Pinus MacClurii*, very nearly related to *Pinus alba* of Canada. Of this, MacClure and his companions brought back cones obtained from Banks Land; and they observed the trunk in the remarkable mountains of fossil wood discovered in that country. The Miocene beds of Iceland have furnished seven species belonging to Pines or Junipers. The *Sequoie* (Wellingtonias) are still more abundant than the pines; this genus played a very important part in the Miocene period, and is found fossil in Europe, Asia, and America. At the present day it includes only two species (*Sequoia sempervirens* and *S. gigantea*), confined exclusively to California. These are the last representatives of this remarkable genus, to which belong the largest trees in the world. We find four species of it in the Miocene beds of the polar regions, three of which also occur at the same level in Central Europe. At this period *Sequoia Langsdorffii* was the most abundant tree in the north of Greenland; and we are acquainted not only with its branches and their leaves, but also with its flowers, cones, and seeds. It occurs also in the north of Canada, in Vancouver's Island, Germany, Switzerland, and Italy, and is very nearly al-

lied to *S. sempervirens*, from which it is distinguished only by the size of its cones, which are larger and composed of more scales. *Sequoia Sternbergii*, which was abundant in Iceland, is very nearly related to *S. gigantea*; whilst *S. Couttsiae*, which is found in Greenland, at Disco and Ataneverdlak, is intermediate between *S. Langsdorffii* and *S. Sternbergii*. The family of the Cypresses is richly represented by three genera—*Taxodium*, *Thujopsis*, and *Glyptostrobus*. The latter two are still in existence in Japan; the *Taxodia* occur in North America. *Glyptostrobus europæus* usually accompanies the *Sequoia Langsdorffii*, as also does *Taxodium dubium*, of which the branches, leaves, and cones were discovered at Ataneverdlak, and which has also been found on Spitzbergen, at about 78° N. latitude. *Thujopsis europæa* is much rarer; its elegant branches have been found in North Greenland, and they are identical with those obtained from amber and at Armillan (near Narbonne).

Among the Taxineæ we remark a *Salisburia* from Greenland; this genus now occurs in the wild state only in Japan.

The number of leafy trees is so considerable that we can only indicate a few species. Several of them resemble trees of our countries; such are the *Beeches* and *Chestnuts*, which are still found in North Greenland at 70° N. latitude. A species of Beech (*Fagus Deucalionis*) is extremely near our common Beech (*Fagus sylvatica*); the leaves are of the same form and dimensions, and have the same nervures, but they are denticulated only at the extremity. This tree was, apparently, diffused through all the northern regions, since we meet with it in Greenland, Iceland, and Spitzbergen. The *Oaks* are still more varied; we count eight species in Greenland, most of them having large, elegantly denticulated leaves; they have some relation to American species. One of them (*Quercus Olafsoni*), which may be traced from the north of Canada to Greenland and Spitzbergen, is the analogue of *Quercus prinus* of the United States. A *Platanus* (*P. aceroides*) was also spread over all these countries; it is even met with in the Eisfjord in Spitzbergen. The *Poplars* furnish a still greater number of individuals than the genera just cited. Two species (*Populus Richardsoni* and *P. arctica*), with *Sequoia Langsdorffii*, were the commonest trees of the polar zone. We can trace them from the Mackenzie to [The *Willows* are very rare, which may well surprise us when we consider that they now form one-fourth of the woody plants of the arctic zone. The *Birches* were abundant in Iceland, where we also remark a fine species of *Tulip-tree* and a *Maple* (*Acer otopteryx*). In Greenland we find a *Walnut*, a *Mag-*

nolia with coriaceous leaves (*M. Inglefieldi*), and a *Plum* (*Prunus Scottii*); and in Spitzbergen a large-leaved *Lime-tree* (*Tilia Malmgreni*). Side by side with these trees, which are analogous to those of the present epoch, we observe several exceptional forms, from the presence of which it is difficult to draw any conclusions. One of these species, which possesses large coriaceous leaves (*Daphnogene Kanii*), probably belongs to the family Laurinæ; four others (*Macclintockia* and *Hahea*) are probably Proteacæ. It is difficult to judge what would have been the habit of these plants. With regard to others, however, analogy indicates that, in all probability, they were shrubs. Thus we find a *Nut-tree* (*Corylus MacQuarrii*) which was diffused through all the polar regions, and occurred in Spitzbergen at 78° N. latitude, as also a species of Alder (*Alnus Kefersteini*). From Greenland we have species of *Rhamnus*, *Paliurus*, *Cornus*, *Ilex*, *Cratægus*, *Andromeda*, and *Myrica*, which ascend to 70° N. latitude. Sarmentose plants were not wanting; a species of *Ivy* (*Hedera MacClurii*) has been found on the shores of the Mackenzie, and of *Vines* two species in Greenland, and one in Iceland: these species approach certain American Vines. It is not difficult to form an idea of the vegetation of the polar regions, at the Miocene epoch, from the indications which we have just given. It consisted of forests of very various leafy and resinous trees, many of which had large leaves of very diverse forms; vines and ivy entwined these with their branches; and beneath their shade grew numerous shrubs and elegant ferns.

What a contrast between this picture and that presented to us by these countries in their present state! Now-a-days Greenland is nothing but an immense glacier, which covers the whole country and sends even into southern latitudes mountains of ice which cool the climate; we can scarcely say that a narrow belt along the shores is freed in summer and enabled to cover itself with a little vegetation. In the Miocene period the limit of Limes, *Taxodia*, and *Platani* was at 79° N. latitude; that of the Pines and Poplars, if we may judge from what we see in the present day, must have attained the pole, or at least the lands nearest to it; for they advance at present 15° further to the north than the Planes. It is a natural conclusion from this, that the extreme limit of trees then followed a line very different from that which we can trace at the present day: it now follows the isothermal line which gives a mean of 10° C. (= 50° F.) in July—that is to say, about 67° N. latitude; so that it scarcely passes the polar circle, whilst then it reached the pole itself.

This fact alone indicates that the climate was very different.

We may add other proofs to confirm our assertion. From the character of the flora of Spitzbergen at the Miocene period we may conclude that under 79° N. latitude the mean temperature of the year was 5° C. ($= 41^{\circ}$ F.); at the same epoch that of Switzerland was 21° C. ($= 69^{\circ}\cdot 8$ F.), judging from the analogy of floras. There is consequently a difference of 16° C. ($= 28^{\circ}\cdot 8$ F.); and for each degree of latitude the mean temperature has fallen $0^{\circ}\cdot 5$ C. ($= 0^{\circ}\cdot 9$ F.) From this it follows that at Spitzbergen, at 78° N. latitude, the mean was $5^{\circ}\cdot 5$ C. ($= 41^{\circ}\cdot 9$ F.), in Greenland, at 70° , it was $9^{\circ}\cdot 5$ C. ($= 49^{\circ}\cdot 1$ F.), and in Iceland and on the Mackenzie, in latitude 65° , it was $11^{\circ}\cdot 5$ C. ($= 52^{\circ}\cdot 7$ F.) These data suffice to explain the character of the flora of this period *.

The difference of temperature between Switzerland, in N. lat. 47° (brought by calculation to that of the sea-level), and Spitzbergen, in N. lat. 78° , is at present $20^{\circ}\cdot 6$ C. ($= 37^{\circ}\cdot 08$ F.), which gives a diminution of $0^{\circ}\cdot 66$ C. ($= 1^{\circ}\cdot 2$ F.) for each degree of latitude. It is therefore evident that at the Miocene epoch the temperature was much more uniform, and that the mean heat diminished much more gradually in proportion as the pole was approached, so that then the isothermal line of 0° ($= 32^{\circ}$ F.) fell upon the pole, whilst now it is situated under 58° N.

It has been asserted that at the Miocene epoch currents might transport wood and vegetable remains to great distances, as is the case now, and that it is very possible that the plants which we find in the fossil state in the deposits of the polar regions may have been carried there in an analogous manner, and may not have lived on the soil where we find their remains. This notion cannot be admitted, as will be easily seen if we consider:—1, the perfect preservation of the leaves; 2, the enormous accumulation of fossil plants in the beds of siderolitic iron-ore in Greenland, associated with great deposits of lignites; 3, the fact that insects are found with the plants; and, 4, the presence of beech-leaves just issued from the bud and still folded, as well as that of flowers, seeds, and fruits associated with the leaves. Certain seeds are found arranged in the same manner as in the berry which protected them; this evidently indicates that the berry itself was buried in the mud. Now it is clear that a berry could not be carried by the waves to great distances.

Whoever will examine, without preconceived ideas, the

* For further details upon this subject consult the '*Flore fossile des Régions polaires*,' by Prof. O. Heer (Zurich, 1867), in which all the plants of the Miocene epoch discovered in these countries are described and figured.

beautiful and varied fossil plants which fill the rocks of Ataneverdlak in Greenland, will be convinced that these plants cannot have come from a great distance. As to the fossil plants of Spitzbergen, it is very evident that they were not brought by marine currents, as we find them in freshwater deposits.

It appears certain, therefore, that at the Miocene epoch the temperature of the polar regions was much higher than in our day; and we are naturally led to inquire what are the causes which may have brought about such a change. We cannot admit the supposition of a displacement of the poles, even regarding it in the same way as Mr. Evans, who has recently maintained this theory. Indeed it is a certain fact that we remark the same phenomena all round the terrestrial globe, not only in the polar zone, but also under southern latitudes. No direct observation seems to us to confirm this hypothesis. We regard as much more important the theory according to which climatic modifications would coincide with modifications in the distribution of the seas and continents upon the surface of the globe. At present the extent of the seas is twice and a half that of the solid earth, and the continents are arranged in much more considerable masses in the northern hemisphere, and especially beyond the tropic. This condition is not normal. If, instead of so unequal a distribution, the lands and seas were equally distributed in all the zones, the temperate and glacial zones would enjoy a climate warmer than at present. Nevertheless, even supposing the most favourable distribution, we should not succeed in producing, between 70° and 79° N. latitude, a temperature sufficient for the development of a flora like that of which the existence in these regions during the Miocene period has just been indicated. Suppose all the continents united in the neighbourhood of the equator, and only a few islands left in the northern regions,—these would enjoy the highest mean temperature to which they could attain, their winters would be comparatively very mild, and yet the heat of the sun could not be sufficient between 70° and 80° N. lat. to allow of the development of a vegetation so rich as that of which we find the traces. Now it is certain that in the Miocene period there was a great extent of solid land in the temperate zone, and even in the polar regions, as is proved to us by the extension of several species of the Miocene flora, which we can follow from the Mackenzie to Spitzbergen.

The explanation of the climatic changes which the study of fossils reveals to us, has been sought in the fact that the gradual cooling of the mass of the globe must necessarily produce a gradual diminution of temperature. This cause may certainly have acted in the most ancient periods; but the Mio-

cene epoch is too nearly approximate to our own to allow of our attributing to it, with any probability, the difference of temperature now indicated.

It seems to us to follow, from the preceding considerations, that it is from the study of phenomena of another kind that we must obtain the solution of the problem that we seek. Let us first examine, in the series of cosmical phenomena, the question of the changes which may have taken place in the position of the earth relatively to the sun. From the point of view which now engages our attention, a great importance has been quite recently attached to the periodical modifications of the eccentricity of the ellipse which is annually traversed by the earth. The form of this ellipse is modified within certain limits in the course of ages. At present it approaches a circle; in 23,900 years its eccentricity will have attained its minimum; then the orbit will again tend to acquire a more elongated form. The mean distance from the earth to the sun is 91,400,000 miles; when the eccentricity of the ellipse is at its maximum it has $\frac{1}{3}$ of this length, when it is at its minimum $\frac{1}{6}$; in the former case the earth departs from the sun 14,500,000 miles more than in the second case. At present the linear value of the eccentricity is three millions of miles. It must also be observed that, at present, the earth is nearest to the sun (at the perihelion) during the winter of the northern hemisphere, whilst in the summer it is furthest from it (at the aphelion). Now the relative position of the line of apsides and of that of the solstices is likewise subjected to a movement of revolution which is accomplished in 21,000 years. In about 10,000 years the summer of the northern hemisphere will fall at the period when the earth is nearest to the sun, and its winter at that when it is most distant. Of course the contrary will take place in the southern hemisphere.

It is assumed that during the periods when the eccentricity of the orbit of the earth approaches its maximum, when the perihelion coincides with the winter solstice, the northern hemisphere must enjoy a shorter and warmer winter, whilst the summer is longer and cooler. During this time the opposite is the case in the southern hemisphere. Its winter is longer and colder, its summer hotter and shorter, because the winter of this hemisphere corresponds with the greatest distance from the sun. Mr. Croll supposes that during this long and cold winter so great a quantity of ice must have been accumulated, that the summer following it (which, although hot, was short) had not the power to melt it entirely, and that it is at this epoch that we must place the *glacial period*. In the northern hemisphere, on the contrary, there would have

been a continual spring, the summer being long and cool, and the winter short and warm. Mr. Stones has calculated that we must go back 850,000 years to reach the epoch at which the eccentricity of the orbit of the earth attained its maximum value, at the same time that the aphelion coincided exactly with the winter solstice in the northern hemisphere. The winter would then have lasted thirty-six days longer; and as it is at this period that the greatest quantity of ice and snow would have been formed, Lyell is inclined to place in it the glacial epoch. But 900,000 years ago, on the other hand, the orbit of the earth would have most nearly approached the circular form, and from this would have resulted a complete change of climatic conditions.

All these speculative theories are certainly ingenious, but it must be remarked that they have not a solid basis; in fact we still only very imperfectly know what is the extent of the action which might be exerted upon the power of the rays of the sun by the distance which they traversed to arrive at the earth. Lyell has pointed out, with reason, that according to Dove's calculation the earth is hotter in July (that is to say, at the moment when it is most distant from the sun) than in December (when it most nearly approaches it). The cause of this is the unequal distribution of sea and land in the two hemispheres, from which it results that the northern hemisphere has a hotter summer, even when the earth is nearest to the sun during the summer of the southern hemisphere. From this fact we may conclude that the mode of distribution of the sea and land on the surface of the globe exerts a *greater* influence upon the climate of each hemisphere than that which can result from the greater or less eccentricity combined with the position of the line of the apsides. On the other hand, however, as Lyell has admirably demonstrated, these two causes, by the combination of their effects, may have had an extremely important influence upon the changes of climate which the observed facts enable us to demonstrate.

It is also possible that the action of the sun has not always been the same; for, by the observation of its spots, we know that great modifications take place upon its surface, whence the possibility of a change in the intensity of the solar rays.

To all these considerations this one may be added:—The sun is not alone in the vault of heaven; millions of celestial bodies likewise shine there and diffuse their light and heat into space. Why, then, may we not suppose that the different regions of space have not all the same temperature? The mathematician Poisson put forward this idea, by calling attention to the fact that the number of stars is so great that they form, as it were, a continuous vault. We also know that the

sun with its planets does not always occupy the same position in space; it probably moves round a fixed star situated at an infinitely great distance. Starting from these data, and supposing that the temperature of the different regions of space is not the same throughout, we should find a very simple explanation of the climatic phenomena which have been mentioned. Thus, if at the Miocene epoch the sun and its planetary system were in a region of space hotter than that in which they now move, this heat must have exerted an influence upon all parts of the terrestrial globe, but the effect must have been most marked in the glacial and temperate zones. If during this immense revolution, or solar year, hot periods succeed to colder ones, or *vice versa*, we may by analogy assimilate the Miocene period to its summer, the glacial period to its winter, and the present period to its spring. It is evident that we must accept the idea of a course of prodigious length, the extent of which our minds cannot yet conceive. A time will no doubt come when we shall succeed in calculating it; and just as we now know the orbit of the earth, future generations may perhaps arrive at a sufficiently accurate knowledge of the orbit of the sun.

Our minds are confused, it is true, in presence of these spaces and periods which to us appear infinite; but this arises from the smallness of the scale according to which we measure space and time, as may be shown by a simple comparison. Suppose the duration of the life of man to be a *single day*; those born in winter could only know by tradition that there was formerly a time when it was hotter, and that this time would return after a long series of generations. The opposite would be the case with those born in summer. To these men of a day, a year would be a period of excessive length, since it would include 365 generations. Now the actual duration of human life corresponds not to a day, but perhaps scarcely to a minute of this great solar year; what inhabitant of the earth can ever know its phases? If he cannot conceive them with his bodily eye, he may do so at least with the assistance of his thought, with the aid of his intellect, which enables him to penetrate the obscurity of the past, and to coordinate the phenomena which have been accomplished in the course of successive periods. The eye of his mind penetrates into the most distant times, as into the remotest spaces of the celestial vault. If the body of man is small in contrast to the immensity of nature, if his life is short in presence of the infinite duration of time, what is not the grandeur and power of his mind, which carries him beyond the course of ages and gives him to understand that in his perishable envelope is deposited the germ of immortality!

XI.—*Remarks upon the Papilio Cocytus of Fabricius and its distinctness from the Adolias Cocytus of Authors.* By A. G. BUTLER, F.Z.S.

IN the fifth volume of the 'Zoological Journal,' pp. 67, 68 (1835), Dr. Horsfield has noticed the distinctness of the *Cocytus* of Fabricius's 'Entomologia Systematica' from the *Cocytus* of his 'Mantissa;' he moreover figures a species, apparently identical with the former, under the more distinctive name of *Cocytina**. It is unfortunate that he should not have figured an East-Indian example, as the Sumatran form now proves to be a distinct species.

I find, by referring to the 'Genera of Diurnal Lepidoptera,' p. 291. no. 9 (1850), that *Adolias Cocytus* is stated to be in the collection of the British Museum from North India†,—a species which in some points agrees with the typical description being mistaken for that insect. Mr. Moore, in his monograph of *Adolias* (Trans. Ent. Soc. vol. v. p. 76. n. 28: 1859), evidently intends the same species, which he quotes as from North and South India.

On referring to the type of *P. Cocytus* in the Banksian collection, I find that it is totally distinct from the above-mentioned species. It is a good deal faded; but the pale band of the hind wings still shows a bluish tinge towards the apex, and in the right-hand wing, which lies behind the fore wing, and has consequently had more protection, there is a distinct flush of bluish violet, indicating that the original colour of the band was blue, and not ash-coloured as stated by Fabricius. The underside of the wings is entirely ochreous, with a submarginal lunulate interrupted band, very indistinct in the hind wings ("*striga postica fusca*," Fabr.), the apex of the fore wings also being tipped with dark fuscous; the fore-wing cell has the usual *litræ*; but in the hind wings they are scarcely indicated. Fabricius describes the underside of the wings as "*omnes cinerascens*;" but there is now no indication of such coloration in the type; and I think, considering the careless manner in which many of the Fabrician descriptions were put together, that it is exceedingly likely that this is an error.

We have a specimen of a species from Assam, and a second without a locality, which only differ from the type in having the apex of the fore wing slightly less falcate, the blue marginal band rather narrower, and the underside of the fore wing with a violet nebulous streak along its outer margin: there

* Vollenhoven has figured a species near *Cocytina* from Java (Tijdschrift voor Entomologie, vol. v. pl. 12. figs. 3, 4) under the name of *Blumei*.

† The original locality (Siam) is also quoted.

can, therefore, be little doubt that the true description of *Cocytus* will be as follows:—

Adolias Cocytus, Fabricius.

♂. Alis integerrimis falcatis, supra nigro-fuscis, lineolis discoideis nigris, margine externo viridi-ceruleo extus violascente, posticis lato: subtus omnibus ochreis; anticis lineolis quinque discoideis, striga sexlunulata submarginali, nebula marginali violacea; posticis lineolis basalibus vix distinguendis, striga submarginali lunulata fusca.

Exp. alar. unc. $2\frac{7}{8}$ – $2\frac{9}{8}$.

The Indian species will of course have to be described; and I therefore propose for it the name of *A. lepidea*.

Adolias lepidea, sp. nov.

Adolias Cocytus, E. Doubleday, List Lep. Brit. Mus. i. p. 104 (1844), but not of Fabricius.

Adolias Cocytus, Westwood in Gen. Diurn. Lepid. p. 291. no. 9 (1850); F. Moore, Monog. Adol., Trans. Ent. Soc. v. p. 70. no. 28 (1859).

Alæ supra maris nigro-fuscae, feminae fuscae; disco medio paulum pallidiore; margine externo pallido cinereo-fusco, margine externo feminae fuscascente, lituris discoideis nigris.

Alæ subtus multo pallidiores, maris castaneo-fuscae, feminae ochraceae disco medio ochreo: posticae extus albicantes; striga maculari submarginali, altera postmedia angulari lunulata, posticis ochraceis; lituris discoideis nigris: anticae margine externo violascente.

Exp. alar. unc. $2\frac{3}{8}$ – $3\frac{1}{2}$.

♂ ♀, North India. ♂ var., South India. B.M.

BIBLIOGRAPHICAL NOTICE.

Figures of Characteristic British Fossils; with Descriptive Remarks.

By WILLIAM HELLIER BAILY, F.L.S., F.G.S., &c. Part I., pages i–xxiv & 1–30; Plates I.–X. 8vo. London: Van Voorst, 1867.

THIS first instalment of a work of good promise, well planned and well begun, is very acceptable to geologists, both amateur and professional. The heavy task that lies before the geological inquirer who wishes to set eyes on any large group of fossils peculiar to a system of strata often checks his progress, and is always a trouble. He may have recourse to Bronn's comprehensive 'Lethæa geognostica,' but it is cumbrous, expensive, and German; nor does it place before him the fossils of the several "formations" of each geological "system," as is proposed to be done in the work before us. The still more voluminous 'Paléontologie française' is further beyond his requirements, being arranged to give every known species in de-

tail. Geinitz, Quenstedt, and others have given geologists general works on fossils; but they fail to be of use to the English geologist, for several reasons. Prof. Owen's 'Palæontology' is of too special a character. To help those, then, who wish to be acquainted with British Fossils and their chief peculiarities in character and distribution, Mr. Baily comes forward with a clear and useful guide, supplied with the latest information.

For educational purposes this book is well adapted, being an aid both to teacher and student; and for the practical geologist it is a desirable *vade mecum*, reminding him of the typical fossils of every stage of strata, whether they are characteristic by peculiarity or by relative abundance.

The work will consist mainly of lithographic plates, accompanied by "explanations" and "descriptive remarks." In each part, published at short intervals, there will be ten plates of figures; and by means of these "it is intended to present to the eye faithful copies of the usual and most important fossils found in or characterizing the various stratigraphical divisions into which fossiliferous rocks are arranged by the geologist, with a view to relieve the mind from the necessity of studying the whole series of extinct forms of organic life, now known as fossils, and so that the general aspect of each particular group may be seen at a glance, conveying, it is presumed, with the explanatory remarks, sufficient information for all ordinary purposes, and supplying an essential aid in the identification of strata."

We really believe that these plates will contain exact representations of both the most remarkable and the most common of fossils (many from *original* specimens), knowing that the author has had a long experience as naturalist, draughtsman, and palæontologist; and indeed this first set of the plates, with their explanations, fully illustrate his talent and conscientious care. We must remark, however, that some of the plates are "woolly" in appearance, and that the printer's work might be better; nevertheless there are but very few real errata.

The "descriptive remarks" in this first Part comprise:—1. A succinct note on Palæontological Geology. 2. A table of the Invertebrate portion of the animal kingdom,—imperfect, however, and very loosely put together. 3. A "table of the Fossiliferous or Stratified Rocks in the order of their superposition" (mainly after that in the Geological Survey Museum Catalogue), which is adapted for England and Wales only, except that the "Cambrian" of Ireland is inserted—that of Scotland and the Laurentian strata of Scotland and the Lewis being omitted. 4. Notes on the assemblage of Fossils of the Cambrian rocks, giving scant credit to the crustacean *Palæopyge*, though in Plate 2 its head is figured as well as its tail. The *Oldhamiæ*, however, are here well illustrated, some of their living analogues being neatly engraved on wood; and others might have been added, if the author had thought enough of filamentous Seaweeds and of the Calcareous Algae or "Corallines" (a name he misapplies to the Hydrozoa throughout); nor does he seem to have

studied Unger's memoir treating of the subject. 5. The Silurian assemblage of Fossils, elucidated with the description of a Trilobite; and then follow (6) notes on the Fossils of the Lower Silurian rocks, (7) those of the *Lingula*-beds; (8) of the Tremadoc Slate; and (9) of the Ilandeilo Flags; and here we have the modern Cœlenterate analogues of the Graptolite well shown in woodcuts; but some would like to have their Polyzoan allies shown also. But these are vexed questions; and altogether, among the fossils of doubtful alliances Mr. Baily walks delicately; nevertheless he might have been bolder in referring more of the so-called Annelids and Fucoids to crustacean galleries and tracks (as our correspondent Mr. Albany Hancock indicated long ago); and *Ribeiria* (not *Ribieria*) might also have gone over to the Crustaceans, as Mr. Salter has suggested. So much for a weak point or two; but we must add that, as this excellent work is intended for amateurs and students, as well as for experts, it would have been advantageous to them if the author had given the meanings of the names of the genera and species. This would be generally of real use in indicating the characters, conditions, or history of the things named; and it would almost always serve in some way, by association of ideas, to enable the reader and thinker to remember both names and things.

A systematic statement as to the relative abundance or peculiar occurrence of the several fossils figured would also greatly enhance the value of this work.

With Plate 10 we enter upon the fossils of the Bala-Caradoc formation; and we look forward with pleasure to the illustration of the other principal groups of organic remains in this convenient shape, which is uniform with Professor Morris's well-known 'Catalogue of British Fossils.'

MISCELLANEOUS.

On the Structure of the Eye in the Gasteropoda, and on the Development of the Eyes in the Animal series. By V. HENSEN.

VARIOUS authors have recently paid attention to the structure of the eye in the Gasteropoda, and more especially to that of the retina; among them are MM. Leydig, Kœferstein, Krohn, Hensen, and Babouchine. The investigations of these naturalists have clearly shown that the retina of the Mollusca is divided into an outer and an inner layer, separated by a thin stratum of pigment. But all these authors do not agree as to the parts of this retina which are directly impressed by the luminous waves. Some, particularly M. Hensen, regard the inner layer as sensible to light; others, on the contrary, consider it to be insensible, and that the luminous rays must pass through interstices of the pigment in order to irritate the outer layer of the retina.

M. Hensen indicates that, in certain theories of vision proposed by the most recent authors, the pigment plays an inadmissible part. Thus, for example, the heat reflected by the pigment has been ad-

duced to explain the phenomenon of vision. As the author points out, the case of albinos shows that luminous perceptions do not cease when the pigment is absent; and we do not know any case in which the pigment is absolutely necessary for the perception of light. The pigment really fulfils two functions. In the first place it absorbs the superfluous light and prevents it from being reflected upon other parts of the retina; and it arrests all the luminous rays which may penetrate into the eye by any other road but the pupil, whether through the cornea or the sclerotic. This second function is of particularly great importance in the Mollusca. In many of these (for example, in the Heteropoda) the parts surrounding the eye are perfectly transparent; and even in the snails the ommatophore is sufficiently transparent to allow us sometimes to see the outer layer of the retina without any difficulty. The luminous rays may, therefore, strike this outer layer of the retina in all directions; and from this M. Hensen justly concludes that it cannot be sensitive to light. Sensibility to luminous rays consequently appears to be peculiar to the inner layer, accessible only to the rays which have passed through the crystalline. This layer alone is comparable to the stratum of bacilli in the Vertebrata.

In comparing the eyes of the Mollusca with those of other animals, M. Hensen directs attention to the difficulty resulting from the variable meanings of terms. The words *eye*, *retina*, *iris* have acquired a perfectly definite physiological sense; but this is not the case with the words *sclerotic*, *cornea*, and *choroid*, because they are used to designate organs with various and still ill-defined functions. Thus, for example, the sclerotic serves at once as the protective envelope of the eye, as the support of the cornea, and as the basis for the attachment of muscles, without its being possible to say that any one of these functions is more essential than the rest. In the Vertebrata the sclerotic and the neurilemma of the optic nerve are justly regarded as prolongations of the *dura mater*. This morphological character ought, apparently, to be the best guide in the investigation of the homologies of the sclerotic; but when we come to animals in which the eyes are not formed as if by a budding of the brain, and in which we can find no *dura mater*, it becomes very difficult any longer to speak of a sclerotic.

With regard to the structure of the retina there is, between the Vertebrata and the Invertebrata, a chasm which seems to defy all homologies. Thus in the former the bacilli form the outer layer of the retina; in the latter they form its inner layer. And yet it is remarkable that, notwithstanding this fundamental difference in the typical organization of the essential part of the organ of sight, the uniformity of organization persists in the accessory organs. Thus, as M. Hensen remarks, in the Cephalopoda, the crystalline continues to be an epithelial production, resulting from an invagination of the skin, as in the Vertebrata. In these higher Mollusca there also exist an iris, a cornea, and eyelids—organs which, it is true, disappear one after the other in this class of animals. The sclerotic appears as if divided into fragments. One portion forms the

outer capsule of the eye, and bears the cornea: another more closely envelopes the retina; it is cartilaginous, serves for the attachment of the muscles of the eye, and reminds us of the sclerotic ring of birds and reptiles. Even in the *Nautili*, however, there no longer remain any of these homologous parts of the sclerotic. In the other Mollusca it would be very difficult to say what we are to regard as the sclerotic. It is equally impossible to distinguish a cornea in them. We cannot say, indeed, that the essential character of the cornea is its being the first refractive medium in the eye. The serpents teach us the opposite of this, since in them the first refractive medium is formed by the eyelids. Moreover, in a great number of Mollusca, the region which is usually designated by the name of the cornea does not present any greater transparency than the rest of the envelopes of the eye.

In the Vertebrata, on the contrary, the *cornea* has a very definite meaning, especially as, from the observations of M. Hensen, it presents a development *sui generis*. In the embryo, immediately after the invagination of the crystalline, this anatomist has seen the cornea appear as a very delicate basilar membrane of the epithelium. As long as the crystalline still contains a cavity there exists between it and the cornea, in front of the pupillar membrane, a sort of gelatinous tissue, exactly similar to that of the vitreous body at the same embryonic period. Neither the sclerotic nor the choroid has any connexion with a similar tissue.

It is equally difficult to determine the homologue of the choroid in the Mollusca. In the Vertebrata this membrane is at once vascular and pigmentary. The concordant investigations of MM. Kölliker, Hensen, Schultze, and Steinlin show clearly that the black epithelium of the choroid is in reality a dependency of the retina; it is formed, in fact, by the outer lamella of the primitive ophthalmic vesicle. M. Hensen asserts that he has ascertained that the cones and bacilli are produced by this epithelium and not by the rest of the retina. Hence the principal character of the choroid is vascularity, and the name of *vasculosa* has frequently been given to it in human anatomy. From this point of view it would be impossible to find the least trace of a choroid in the Invertebrata. The intra-retinic pigment layer of the Mollusca in particular by no means merits the name of choroid.

It is generally supposed that the ophthalmic vesicle which subsequently forms the retina is nothing but an extravagination of the central nervous system. The embryological researches of M. Hensen tend not only to confirm this view, but also to establish a complete parallel between the different layers of the retina and those which primitively form the central nervous tube.—*Archiv für mikr. Anat.* Bd. ii. 1866, p. 399; Abstract by E. Claparède in *Bibl. Univ.* November 25, 1867, *Bull. Sci.* pp. 268-271.

Adanson's Black Crocodile. By Dr. J. E. GRAY.

Dr. Alexander Strauch asserts that Adanson's "Crocodile noire" is not *Crocodilus frontatus*, but *C. cataphractus*. Adanson mentions

three crocodilians occurring in Senegal—an olive and a black crocodile, and a false gavial. There are constantly received from the Gambia and various parts of the west coast of Africa only three species of crocodilians, viz.:—1. *Crocodilus vulgaris*, which is olive; 2. *C. frontatus*, which is black, and is known, on the coast, by the name of the Black Crocodile, or Black Alligator; and 3. a gavial-like crocodile (*C. cataphractus*, Cuvier).

If the "*Crocodile noire*" is not *C. frontatus*, then Adanson, one of the most intellectual and advanced naturalists of the last century, must have entirely overlooked the latter, and have given the name of the black crocodile and the false gavial to *C. cataphractus*, which is more like a gavial than a crocodile.

Dr. Strauch's Essay is a very elaborate and careful compilation, stating many things as positive which he could not have verified by the examination of specimens; for, unfortunately, the collection under his care is very small, and consists chiefly of very young specimens, and he does not appear to have visited other European or American collections: in fact the materials are not sufficient to be the basis of a monograph of crocodilians of any authority or originality.

Rare British Sharks.

The British Museum has lately received from Mr. William Laughrin, of Polperro, a specimen of the spinous shark (*Echinorhinus spinosus*), 7 feet long, and of the six-gilled shark (*Hexanchus griseus*), 6 feet long. These fish have each been recorded only once before as having occurred on the British coast.—J. E. GRAY.

The Australian Representative of Cynthia cardui.

To the Editors of the Annals and Magazine of Natural History.

GENTLEMEN,—In most works referring to the distribution of the English *Cynthia cardui*, or Painted-Lady Butterfly, it is said to be common in Australia. There is in abundance, about Melbourne and in many other parts of Australia, a *Cynthia* with the general appearance and habit of the *C. cardui* so closely represented that every entomologist I know refers it to that species. The Australian species differs from the European one constantly, however, in having the centres of the three lower round spots on the posterior wings bright blue, and having two other blue spots on the posterior angles of the same wings, the corresponding parts of the European form being black.

As the collector I employ for the museum here, Mr. W. Kershaw, mentioned this to me six or seven years ago, and I have found the character constant in all the specimens I have examined since, I should wish to draw attention to the fact by naming the Australian insect *Cynthia Kershawi*.

I have, &c.,

FREDERICK M'Coy.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 2. FEBRUARY 1868.

XII.—*Notes on various Species of Ctenodus obtained from the Shales of the Northumberland Coal-field.* By THOMAS ATTHEY.

THE curious genus *Ctenodus* was founded by Agassiz on a single specimen of a palatal tooth procured from the compact coal of Tong, and preserved in the Leeds Museum. It was named *C. cristatus*, and was described in his 'Recherches sur les Poissons Fossiles,' where it is tolerably well figured. He mentions two other species, under the respective names of *C. alatus* and *C. Robertsoni*—the former from Ardwick, the latter from Burdick House; but I can find no specific description of either*, though there is an account and figure of the microscopic structure of *C. Robertsoni*; but these do not assist us at all in determining its specific identity. So far as I am able to ascertain, *C. cristatus* is, then, the only described species of this genus belonging to the Carboniferous system; I am therefore gratified to find myself in a position to add several new species of *Ctenodus* to the fauna of our Coal-measures.

During my long-continued examination of the shales in the neighbourhood of Newcastle I have not only found divers specimens of Agassiz's species, but have also obtained five or six others, all of which are distinguished by well-marked characters. It is my intention to give in this communication short descriptions of the whole of them, reserving for some future occasion more lengthened details of their characteristic features. In the first place, however, a few remarks may be made respecting the fishes to which this beautiful armature belonged.

Agassiz thought they were Placoids; and so they were deemed to be for several years, until Hugh Miller† obtained

* From a remark in Agassiz's 'Monogr. des Poiss. Foss. du Vieux Grès-rouge,' it appears that both species are inedited.

† See 'Footprints of the Creator,' p. 62.

and described similar palatal plates attached to the roof of the mouth of a small fish belonging to the Old Red Sandstone, which had previously been described under the generic appellation of *Dipterus* by Sedgwick and Murchison*, thus at once removing *Ctenodus* from among the Sharks and Rays, and placing it in the order Ganoidei. Since that time *Ctenodus* and *Dipterus* have been considered synonymous, and have recently been transferred to a distinct family named Ctenodipterini—*Ceratodus* and *Tristichopterus* being provisionally associated with them†.

There is nevertheless some doubt as to the propriety of merging the genus *Ctenodus* in that of *Dipterus*. In the early part of this year (1867) I was fortunate enough to meet with a small fish in the shale at Newsham, which, though in a very imperfect condition, exhibits some features that perhaps should make us pause before we lay aside altogether the generic appellation *Ctenodus*.

The specimen alluded to is proved to belong to this genus by the presence of four dental plates (two palatal, two mandibular), three of which are distinctly displayed in the crushed head, and the fourth is inferentially recognizable. Now the scales of our specimen, which are in a disturbed state, seem to differ considerably from those of *Dipterus*, in which they are described to be perfectly cycloidal—that is, that they are circular and imbricated‡. In the Newsham species, which is named in the sequel *C. elegans*, though they must be considered also of the cycloidal type, yet they are not truly so, notwithstanding that they are imbricated. When detached, they are seen to be parallelogrammatic in form, with the posterior or exposed end well rounded, the anterior only slightly arched; the sides are nearly parallel, being a little inclined inwards or hollowed; in length they are nearly twice their breadth. Some few, however, differ very much from the above description, being shaped like a battledore. These have the posterior half greatly enlarged and rounded, the anterior portion being much narrowed and truncated. They are all thin and delicate, but large for the size of the fish, and are minutely grooved or plaited from end to end, the ridges being very finely denticulated and curved towards the centre of the rounded extremity, where they become confused and irregularly nodose. Thus in the centre of the exposed portion there is a sort of rosette which is defined posteriorly by incomplete concentric wrinkles; a few similar wrinkles or marks of growth extend

* Trans. Geol. Soc. ser. 2. vol. iii. (1835).

† Huxley, 'Memoirs of the Geological Survey,' decade 10, p. 24.

‡ Fred. McCoy, 'Synopsis of British Palæozoic Fossils,' p. 591.

to the anterior extremity. The whole surface is covered with a coating of enamel, which considerably obscures the markings. On the exposed extremity the enamel is thickened and is very finely granulated, but here it is never perfect, the greater portion of the ornamentation being always exposed; or, at least, it is so in my specimen. The under surface of the scale is also grooved lengthwise, but with great inequality, and the grooves are so strongly and irregularly pitted that the ridges which bound them are distinct only at the margins.

On the whole, then, it is evident that the scales of our fish differ considerably from those of *Dipterus*, in which they are described as nearly circular when detached; the sculpture or ornamentation of the surface also seems to vary. There is likewise another and perhaps more important difference found in the dental plates. In *Ctenodus* these plates are what the name implies—solid expansions of dense matter apparently composed of dentine and bone; and the ridges are equally solid outgrowths of the surface of the plates, bearing tubercles or denticles; or, in other words, the plates are covered with denticulated ridges. In *Dipterus*, on the contrary, the dental organs are uniformly spoken of by Hugh Miller as “patches of palatal teeth”*; and Agassiz describes the ridges or “carinæ” of specimens obtained in the Old Red Sandstone of Russia as “composed of series of imbricated and articulated teeth”†; and the figures representing them entirely confirm the description. In the *Ctenodi* this arrangement cannot be said to exist, though there are in a few of the species slight traces of something of the kind, particularly in *C. elegans*.

It may, however, be doubted how far such characters should be considered of generic importance. They point out, nevertheless, the propriety of retaining for the present, at least, until more is known respecting them, the generic appellation of *Ctenodus* for our coal-measure Ctenododipterini.

The body of the Newsham specimen is not well defined; but as far as the general characters can be determined, they agree with those of *Dipterus*. The head is apparently round and short, being about one-fourth the length of the entire fish, which is 3 inches long; and it exhibits in a distinct manner the underside of the basisphenoid and the præsphénoid bones united together. They assume the form of a rhomboidal plate, with a flattened process extending from the anterior and posterior angles; the bones bearing the dental plates have been displaced. The two opercula, which are each formed of a

* *Op. cit.*

† Monographie des Poissons Fossiles du Vieux Grès-rouge, troisième livraison, p. 123, tab. 83.

single piece, are equally distinct; they are thick and well-rounded, being only slightly elongated transversely, and have the upper or hinge-margin flattened, the surface irregularly granulated, punctured, and enamelled. The tail is in a confused state; but there can be little doubt that it is heterocercal, of the rhomboidal type. And there are traces of an anal and a ventral fin immediately before the caudal; but it is impossible to say whether or not they are lobed. There are a few slender, curved bones scattered about behind the head, which have the appearance of ribs; these and the bones of the head alone have been ossified; the vertebræ have all disappeared.

Such is the description of *C. elegans*, so far as it can be determined by the imperfect remains of the specimen in my possession. That it is specifically distinct from the Old-Red-Sandstone species is evident enough; and it seems quite probable that it even differs from them generically. It is much smaller than most of the *Dipteri*—though it is apparently not full-grown, as the teeth are considerably smaller than the largest specimens of them belonging to this species in my possession; and, on account of its minuteness when compared with the largest species of *Ctenodus* from the coal-measures, there is some doubt whether it may not be generically different also from them. It is not more than three inches long, as has been already stated, while three at least of the larger species cannot be less than four or five feet from head to tail. The sphenoid bones previously mentioned of *C. elegans* are together about half an inch long; the same bones of the large species alluded to must have been at least eleven inches in length.

From the fragments of a large sphenoid and palatal bones in my possession, it is possible to restore this portion of a skull that probably belonged to *C. cristatus*, which is not the largest species; and we are thus enabled to form an approximate estimate of the size of the head, which must have been upwards of twelve inches long and nine broad. Therefore, assuming the proportions to be similar to those of *C. elegans*, we arrive at the conclusion that these large *Ctenodi* were not less than four or five feet in length.

This estimate of the size of these animals receives some support from the fact that very large opercular plates occur in the same shales in which the palatal armature is found. I have in my possession six or seven different kinds of opercula, all having the essential characters of those found in connexion with the head of *C. elegans*; that is, they agree with them in the roundness of their form, in being composed of a single solid piece, and in the surface-granulation and enamel. So

similar are they, indeed, to those of the small species (*C. elegans*) that it is impossible to deny the high probability of their having belonged to species closely allied to it; and at the same time they are readily divisible into species.

The largest of these plates is five and a half inches in diameter; it is almost orbicular, with the hinge-line flattened, and with a rounded process projecting a little at each end limiting its extent: three or four specimens of this large operculum have occurred. The next in size, of which I have two specimens, is four inches across its longest diameter; it is considerably elongated in the transverse direction, being pretty regularly oval; the hinge-line is straight, and strongly defined by two lateral processes. The third operculum is two and a half inches in diameter. It has a finely granulated surface, and the contour is circular and somewhat sinuous; the hinge-line is well defined by two rather acute processes, and is longer than usual. Another orbicular species, about the same size, has the margin less sinuous, and the hinge-line shorter and not so well marked by lateral processes. Besides the above, one or two much smaller but rather obscure kinds have occurred, as well as separate plates of *C. elegans*. And one belonging to *C. obliquus* has been found connected with the palatal teeth and scales. This and the scales will presently be described along with the oral armature of that species.

Now, should it be denied that these large opercular plates belong to the *Otenodi*, it may be asked to what other fishes of the coal-measures can they be assigned? *Rhizodus*, *Rhomboptychius*, and *Megalichthys* are the only large species that occur to which they could, according to our present knowledge, belong. The other large coal-measure fishes are all Placoids, and are therefore out of the question. *Rhizodus* and *Rhomboptychius* are, however, apparently closely allied to *Holoptychius*, in which the operculum is composed of more than one piece; and in the former therefore the gill-cover is in all probability similarly composed; while in *Megalichthys* the character of the enamel and form of the operculum sufficiently prove that the large opercula above alluded to cannot belong to it.

In the same shales likewise occur strong well-arched ribs, the largest measuring six or eight inches in length. These also probably belong to the larger *Otenodi*; and this probability becomes almost confirmed when we refer to the fact of the ossification of the ribs in *C. elegans*, and that the proportion they bear in this species to the length of the fish is just about the same that those large ribs bear to the larger *Otenodi*, which have been already estimated at four or five feet long. These

ribs cannot have belonged to any of the other large species of our coal-system, as none of them have, so far as known, ossified ribs; neither can they be assigned to *Campylopleuron*, a new genus recently proposed by Prof. Huxley* for some large coal-measure fishes found in Ireland, which have not only ossified ribs, but have also large opercula. These opercula, however, being "characterized by a raised longitudinal rib," differ from those of *Ctenodus*, which have no such process or "rib."

All the tooth-plates described in the sequel of this communication have such a general resemblance to each other that there can be no doubt of the close relationship of the fishes to which they belong. And, moreover, the bones to which many of them are found attached closely resemble each other. The palatal tooth (or that which has been so designated) is seated on a broadish flattened bone which, with one exception, is never more than twice the length of the tooth, and is usually considerably shorter; and it is always much expanded at the posterior extremity. This is probably a maxillary bone; and the two branches, when united, have much the appearance of an upper jaw. The propriety, therefore, of calling these palatal plates or teeth may be questioned. The homologies, however, of these parts must be left for the present untouched†. The mandibular tooth is always much narrower than the palatal, and the branch of the mandibulum on which it is placed is not so wide as the bone supporting the palatal tooth, neither is it so much expanded at the posterior end; it is, however, strong and rather massive.

There are two species that have the surface of the teeth with smooth ridges, not tuberculated or denticulated as they are in all the other kinds. These two have consequently some resemblance to the palatal plates of *Ceratodus*, apparently a closely allied form. When further research shall have thrown more light on these obscure species, it will then be time enough to consider the desirableness of dividing this apparently natural group into separate genera.

I shall now conclude this brief communication with concise descriptions of the various dental plates that have come under my observation, retaining the denomination of palatal plates or teeth for the upper pair, though the bones to which they are attached have all the appearance of maxillaries, and so they will be named in the following descriptions.

* Geol. Mag. vol. iii. p. 166.

† This matter is undoubtedly discussed in Prof. Pander's 'Monograph on the *Ctenododipterini*;' but I have not seen that important work.

1. *Ctenodus cristatus*, Agassiz,

Poissons Fossiles, vol. iii. p. 137, pl. 19. fig. 16.

Tooth plate-like, rather thin, irregularly elliptical, inclining to ovate, $2\frac{1}{4}$ inches long, $1\frac{1}{8}$ inch broad; the upper surface somewhat hollowed or concave; the inner margin well arched, the outer much less so; the whole surface is covered with twelve close-set, transverse ridges, which are studded from end to end with closely arranged conical tubercles; the ridges increase in size as they approach the outer margin, and, being inclined towards the anterior and posterior margins, assume a tendency to a radial disposition; the grooves between the ridges are angulated; the tubercles are perfect only at the outer margin, where they are covered with a coat of brilliant enamel, and here they are seen to have the outer face flattened, the base of each tubercle or denticle being subtriangular; elsewhere they are much worn and somewhat compressed at the sides in the direction of the ridges, the whole surface of the tubercles and ridges exhibiting a coarse irregular granulation.

The above description is of a palatal tooth which has the entire right ramus of apparently the maxillary attached. The tooth itself is considerably more than half the length of the bone, the posterior extremity of which is very wide and truncate.

Four or five other specimens have occurred; but they are considerably worn, the tubercles in some instances having almost disappeared; two are mandibular, two palatal; the former are very much narrower than the latter.

There can be little doubt that this is Agassiz's species, though my specimens are scarcely so broad as that represented in the 'Poissons Fossiles,' and they have likewise the posterior margin a little more produced. All the specimens are from the band of dark shale overlying the Low-main coal-seam at Newsham.

2. *Ctenodus tuberculatus*, n. sp.

Tooth plate-like, thick, with an irregular ovate outline, $2\frac{3}{4}$ inches long, $1\frac{1}{8}$ inch broad, the narrow end posterior; the inner margin gibbous or angulated in the centre; the outer margin a little convex; the surface is slightly convex, and is furnished with twelve or thirteen deep, sharp, parallel, approximate ridges, which are strongly tuberculated towards the outer margin, and divided by narrow, deep, angulated grooves; they are arched posteriorly and enlarged towards the exterior border, but do not at all assume a radial ar-

rangement; the anterior ridge, which is wider than the others, is reflected and prolonged for some distance beyond the outer margin; the tubercles are conical, with obtuse points; those next the external border are coated with shining enamel, and are well produced.

The mandibular tooth differs from the palatal in being narrower, and is so convex as to resemble the longitudinal section of a cylinder; the two or three anterior ridges, too, are much shorter than the rest, the inner margin sloping rather rapidly away in front.

There are half a dozen of this species in my collection, all of which were obtained at Newsham; and in the Newcastle Museum there are two others, which were likewise procured from the same locality, and are from the collection of G. B. Forster, Esq. They are all in excellent condition, agree perfectly well in every respect, and can be at once distinguished from *C. cristatus* by the deep and sharp ridges and by the form of the tubercles, which in *C. tuberculatus* are always exactly conical (when they are in a fresh state) at the outer margin. When worn, however, they are much flattened at the sides in the direction of the ridges; and then they are wedge-shaped, and they and the whole of the ridges become granulated.

3. *Ctenodus corrugatus*, n. sp.

Tooth plate-like, thin, subtriangular, 3 inches long, 2 inches broad; the surface is slightly convex, and raised into nine stout, somewhat irregular, rounded ridges or wrinkles, the grooves dividing them being wide and rounded; the ridges die out towards the inner and outer margins, but are enlarged a little as they approach the external border, and are indistinctly and irregularly tuberculated; the inner margin is nearly straight, the outer slightly convex, the anterior slopes forward from the inner margin, and the posterior is produced and rounded. The whole surface is strongly and irregularly punctured.

I have seen only one specimen of this fine, large, distinct species: it is a palatal tooth, and is in a very good state. It was obtained from the Collingwood Main Pit, and was presented by George Johnson, Esq., to the Newcastle Museum. It is readily distinguished from its allies by the fewness of the ridges, by their roundness and wide separation, as well as by their greater size and general form.

4. *Ctenodus obliquus*, n. sp.

Tooth depressed, lanceolate, $1\frac{1}{2}$ inch long, $\frac{1}{2}$ inch broad; the in-

ner margin regularly and much arched, the outer only slightly curved; the surface with six or seven strong, compressed, sharp-edged ridges, placed transversely in a somewhat radiating manner towards the outer margin, where, being enlarged, they are curved downwards and denticulated; the anterior ridges are very oblique, being much inclined forwards; the denticles or tubercles are much compressed in the direction of the ridges, and are lancet-formed, with sharp points; they are coated with brilliant enamel in finely preserved specimens. The above is the description of the palatal tooth; the mandibular is narrower than the former, and is broadest in front, tapering pretty regularly to the posterior extremity; the anterior ridge is very wide, and much produced beyond the outer extremities of the others, and they are all more curved downwards than those of the palatal tooth.

This is a very distinct form, and cannot be confounded with any of the other species. I have collected between forty and fifty specimens of it, most of which were procured from the Low-main shale at Newsham; the rest are from Cramlington: many of them have the jawbone attached in a very perfect condition. The palatal tooth is a little more than half the length of the bone, the posterior extremity of which is much expanded and truncated. The mandibular bone is not much widened posteriorly, and is about half as long again as the tooth.

The specimens vary much in size, the largest being a little over an inch and a half long, while the length of the smallest is not more than three-eighths of an inch. The former has seven ridges, the latter six; so that it is evident that age does not make any material change in this respect. This is highly satisfactory, as we can with greater assurance assume that the number of ridges is a good specific character.

The anterior portion of a fish of this species has occurred at Newsham, exhibiting one of the gill-opercles and two of the dental plates with the denticles interlocked; numerous scales are also displayed, but they are in such a mashed-up state that the characters cannot be determined with precision. Enough, however, is seen to show that they agree with those of *C. elegans*, though the ridges or plaits ornamenting the surface are not so numerous and are considerably coarser; the rosette, too, in the centre of the exposed portion is not so conspicuous, and seems to be smaller. The opercular plate, which is upwards of an inch across its longer diameter, and a little more than three-quarters of an inch in the other direction, is thick and irregularly ovate, with the margin sinuous; the

hinge-line is long, and has a slight projection in the centre; the surface is strongly punctured and granulated.

5. *Ctenodus elegans*, n. sp.

Tooth depressed, triangular, upwards of $\frac{3}{8}$ inch long and $\frac{1}{10}$ inch broad; the inner margin is produced and angulated in the centre, whence it slopes in front and behind towards the outer margin, which is regularly but slightly arched; the surface is provided with eight strongly denticulated ridges, which radiate from the inner marginal angle, where they are very minute, to the outer border; the anterior ridge is a little produced at the outer margin beyond the rest; there are six or seven denticles or tubercles on each ridge; they are much compressed at the sides, are sharp-pointed and lancet-like with the inner limb a little shouldered, where there is occasionally a minute toothlet; the denticle and ridges are coated with enamel, and shine very brilliantly.

There are sixteen specimens of this minute species in my collection; they were obtained at Newsham and Cramlington.

The mandibular tooth is very similar to the upper one, but is a little narrower; the latter is somewhat more than half the length of the maxillary bone, the posterior extremity of which is not much enlarged, and is diagonally truncated.

This is the tooth before alluded to as having been found in connexion with the head of the entire fish, of which a general description has already been given. It is therefore unnecessary to say more respecting it on the present occasion.

6. *Ctenodus imbricatus*, n. sp.

Tooth depressed, very thick, hollowed or slightly concave, $2\frac{1}{4}$ inches long and upwards of an inch broad, with the inner margin well and regularly arched, the anterior slope being much longer than the posterior; the outer margin is nearly straight, but, on account of the projection of the surface-ridges, is coarsely denticulated; there are six of these ridges or plaits; they enlarge rapidly towards the outer margin; they are strong, smooth, and somewhat distant from each other, and, though mostly inclined forwards, are laid over towards the posterior end, having an imbricated appearance; the grooves dividing the ridges are angulated; the surface is minutely granulated, and the edges are enamelled. The mandibular tooth is very narrow and fusi-form; the ridges are not imbricated, and the grooves are scarcely angulated.

This species is not common : I have found only six or seven specimens of it ; they were all obtained at Newsham. Two of these, an upper and a lower, are large and in an excellent state of preservation ; the others are quite small, but, like the large ones, have six ridges, and agree with them in every particular.

This and the following species have some resemblance to *Ceratodus*, but correspond in every respect to *Ctenodus*, except in the deficiency of tubercles or denticles on the ridges.

7. *Ctenodus ellipticus*, n. sp.

Tooth flattened, thin, elliptical, $1\frac{1}{2}$ inch long and $\frac{3}{4}$ inch broad ; the inner and outer margin irregularly arched ; the surface with five transverse, smooth, distant, angular ridges, increasing in size towards the outer margin ; the furrows are wide and round, and the anterior and posterior margins of the tooth are extended a little beyond the ridges before and behind ; the whole surface, including the ridges, is minutely punctured. The mandibular tooth is narrow, with the inner border gibbous ; in other respects it agrees with the upper or palatal tooth.

The maxillary bone is considerably more than twice the length of the tooth, and has the posterior extremity greatly expanded and truncated.

Five or six specimens of this tooth have come into my possession. They occurred at Newsham, and are all fully developed and in good condition.

This well-characterized species is not likely to be mistaken for any of those above described. The only one with which it might possibly be confounded is *C. imbricatus* ; but the comparative thinness of the plate and the non-imbrication of its ridges sufficiently distinguish it.

XIII.—*On the presence of two Glandular Sacs in the Cephalothorax of the Phalangiidæ*. By Dr. A. KROHN*.

ON the dorsal shield of the cephalothorax of the *Phalangiidæ*, close to each of its lateral margins and a little way from their junction with the anterior margin, there is a rounded elongate opening, which was observed by Latreille, and through which the point of a fine needle may easily be passed to a certain depth. Each of these apertures is surrounded by a thickening of the integument projecting in the form of a wall or chitinous

* Translated by W. S. Dallas, F.L.S., from Wiegmann's Archiv, 1837, pp. 79-83.

ring, often of a blackish colour; it leads into a roundish sac, often wrinkled in folds, situated in the cephalothorax, and communicating with the orifice by a short, narrow canal or neck. In many species (*Cerastoma cornutum*, *Phalangium parietinum*) the two sacs immediately attract the eye, after the careful removal of the dorsal shield, by their dark tile-red or dark-brown colour, whilst in other species (*Opilio hystrix*, *Leiobunum rotundum*) they appear quite destitute of pigment, and are therefore at first easily overlooked*.

The two sacs, already noticed by that very meritorious observer Treviranus, but erroneously regarded by him as two lateral eyes, prove, upon closer examination, to be glands, the intimate structure of which resembles that of many glands of Insects. In the first place we may distinguish a very delicate outer envelope or *tunica propria*, immeshed in tracheal ramifications; this is followed by an epithelium composed of secretory cells, which is lined by a very transparent cuticle or *intima*, bounding the cavity of the sac and thrown into numerous fine folds. This intima is continuous with the integument at the exterior orifice, and consequently proves to be a greatly attenuated inversion of the latter into the sac.

The secretory cells lie close together in a single layer, and contain, besides a turbid, finely granular substance, a roundish nucleus, and in the vicinity of this a vacuoliform cavity, which usually exceeds the nucleus more or less in size. Each cell appears to be connected with the intima by an extremely fine efferent canal. The presence of these little canals may be easily demonstrated by the action of a weak solution of potash upon the sac, by which the cells and pigment are indeed dissolved, but the canals and the folded intima are thereby only brought more distinctly into view. The layer of cells may be most distinctly perceived in *Leiobunum*.

In *Cerastoma cornutum* and *Phalangium parietinum*, in which the sacs, as already stated, are of a dark tile-red or brown colour, the pigment, consisting of very minute granules, is situated between the cellular layer and the intima, but seems, at least partially, to insert itself between the cells. In these cases the cellular layer extends to the neck of the sac, and the excretory canalicula are much longer than in *Leiobunum rotundum* and *Opilio hystrix*; at the same time they are strongly coiled together, somewhat in the same way as the blood-vessel in the glomerules of the kidneys of Vertebrata. *Opilio hystrix*, the largest of the indigenous species in our

* In *Opilio hystrix* only the neck of the sacs shows a blackish or reddish-brown tinge.

district [near Bonn], in which the cells may likewise be traced to the neck of the comparatively large sac, possesses the shortest and widest canals, merely bent into simple loops. In *Leiobunum*, on the contrary, the cells occupy only the bottom of the sac, sometimes, however, extending a little higher up; the canals are certainly shorter and less strongly twisted, but not less fine than in the two species first mentioned.

In all the species named the canals appear to grow gradually a little wider, a little before they reach the intima in order to open into the cavity of the sac. It is, however, quite uncertain from what part of the cell the canal originates. Notwithstanding many attempts, I could never succeed in discovering any mixture fitted to demonstrate the direct connexion of the canal with its cell. Nevertheless, from analogy with certain glands in insects, we may assume that the canal issues from the vacuoliform space. Thus, according to Leydig's observations, there is a similar cavity, but furnished with a distinct membrane, in the cells of the salivary gland occurring in the proboscis of some Diptera. As shown in Leydig's excellent figures, we here see the excretory tubule decidedly originating from this vesicle*.

With regard to the secretion of the glandular sacs, I must confine myself to a few statements, and these, indeed, not of a kind to lead to any certain conclusion as to its exact nature and its employment during life. In the sacs of some individuals of *Phalangium* and *Leiobunum* I detected very small crystalline deposits, which had a straw-yellow colour by transmitted light, and seemed to resemble quadratic or rhombic tables. Amongst them there was in some cases a larger and definitely developed crystal, apparently an octahedron with flat truncated ends. In another example of *Leiobunum*, on the contrary, the sac was distended by a milk-white fluid, which, under the microscope, proved to consist of numerous, small, colourless oil-drops.

To refer to the observations of preceding naturalists with relation to this subject, it may be mentioned, in conclusion, that Treviranus, misled by the rounded form of the sacs, and still more by their dark-brown pigment, regarded them as two accessory or lateral eyes in *Phalangium opilio*, Linn. (*P. parietinum*, De Geer)†. The external orifices of the sacs were taken by him for the corneæ of these supposed eyes, although Latreille several years before had recognized their true nature, but certainly referred to them, without any clearly apparent

* Leydig, "Zur Anatomie der Insekten," Müller's Archiv, 1859, p. 69 et seq., pl. 2. fig. 19 (*Musca vomitoria*) and pl. 3. fig. 26 (*Tabanus bovinus*).

† G. R. Treviranus, Vermischte Schriften, vol. i. p. 25.

reason, as stigmata. This opinion is still maintained by several recent observers, especially Leydig* and Meade†. As regards Tulk, there is nothing in his well-known memoir‡ differing essentially from the opinion of Treviranus§.

XIV.—*Observations on the Distribution of some Species of Nudibranchiate Mollusca in the China Sea.* By Dr. C. COLLINGWOOD, F.L.S.

IN my rambles upon numerous beaches on the coast of China, Formosa, Labuan, Singapore, &c., I always kept my eyes open for the species of these often beautiful animals; and being tolerably well acquainted with their habitats and the character of the most likely localities for meeting with them, I was in hopes of making a large collection of perhaps new species from these seas. In point, however, of the number of species that rewarded my search I was disappointed, and not a little surprised at the paucity of individuals and the rarity of species. I expected to find such animals in abundance upon tropical shores; whereas, although day after day I have searched for them, it has been only now and then that I have been rewarded by finding one. The shores of these regions, so far as I have had opportunity of examining them, are less fertile in species than those of our own country; and whether this arises from the season of the year at which my examination has been made, or from local circumstances, I

* "Zum feineren Bau der Arthropoden," Müller's Archiv, 1855, p. 433.

† "Monograph on the British Species of Phalangiidae," Ann. & Mag. Nat. Hist. ser. 2. vol. xv. p. 395.

‡ "On the Anatomy of *Phalangium Opilio*," Annals of Natural History, ser. 1. vol. xii. p. 153.

§ I may be permitted to notice here a matter somewhat beside the present question. In the same volume of the 'Annals and Magazine of Natural History' (ser. 3. vol. xvi.) in which the translation of my memoir on the male generative organs of the *Phalangiidae* appeared, there is a short notice by Sir John Lubbock, in which he indicates that four years previously, in a memoir published in the 'Philosophical Transactions,' he had explained the same subject in a manner essentially agreeing with my observations. Mr. Lubbock was kind enough to send me this important memoir (Notes on the Generative Organs of the Annulosa, l. c. 1861, p. 610), which had been overlooked by me; and from it I certainly perceive that Lubbock is perfectly justified in claiming the priority with respect to the correct interpretation of the previously misunderstood testis and the proof of its connexion with the *vas deferens* through the two canals which I indicated in my paper as *vasa efferentia*. The same memoir also contains some indications of the structure of the accessory sexual glands, in the cells of which, I may remark in passing, I have lately met with a vacuoliform cavity besides the nucleus.

know not; but this I do know, that it has not been for want of diligent search, made day after day under a tropical sun, the result of which was that I have counted one a prize, the more valued from its infrequency.

The first time I had an opportunity of ransacking a new shore was at Aden, where I procured three specimens of what is most probably the *Bornella digitata* of Adams, a very beautiful species, which Mr. Adams discovered in the Straits of Sunda, when voyaging in the 'Samarang.' It also occurs among the Madras Nudibranchs collected by Sir Walter Elliot, and described in the 'Zoological Transactions' by Messrs. Alder and Hancock. On both these, the only other occasions on which they have been met with, two or three specimens only were found. Thus we have this little animal extending from side to side of the Indian Ocean, and occurring also at an intermediate station, on the Coromandel coast.

On some rocks in the middle of Hongkong Harbour I searched in vain, although I had been informed that some species were to be found there; and my informant having conducted me to the spot, we were both equally unsuccessful. Almost the next place which I had any opportunity of examining was the basaltic rocks of Makung Harbour, in the Island of Ponghou, Pescadores archipelago. These shores were remarkably barren of most classes of marine animals; but I was here fortunate enough to meet with a specimen of an extremely richly coloured species of *Doris*, which Mr. Hancock tells me he believes to be like the *Doris Barnardii* of Kelaart, a MS. species which he met with on the shores of Ceylon. This species, probably a species of *Chromodoris* (A. & H.), is marked with deep-blue and yellow spots upon a light-blue ground, the tentacles and branchiæ being of a bright vermilion. It is a question at present whether this species be really the Ceylon species of Kelaart; but it is certain that I afterwards met with the same species on two occasions upon the shores of Labuan, separated from the first locality by the whole extent of the China Sea, or about 20° of latitude. A very minute species, of a scarlet colour, measuring only one-eighth of an inch in length, I found also in Makung Harbour; but its minuteness did not prevent me from meeting with it again afterwards upon the coast of China, about 150 miles further north.

In Formosa, Kelung Harbour (on the north-east side) was the only place I was able to examine; and here the result of numerous searches among the sandstone and coral rocks was but three (new) species—one a small blue *Doris*, but the other two of greater interest. Both of them were remarkably beau-

tiful species; but one of them possesses especial interest as probably representing a new genus of swimming Nudibranchs, its natation being performed by a vertical or up-and-down motion, and not, like that of *Bornella*, by a lateral, vermicular movement. I met with neither of these species, nor the next to be mentioned, on any other occasion.

When dredging about 170 miles to the north-east of Formosa, in 60 fathoms water, amidst a mass of delicate branching corals &c., I obtained a glorious new species of *Chromodoris*, translucent, of a rich amethystine tint, with yellow tentacles and branchiæ. And I may be permitted to mention that at the same time and place I obtained large specimens of *Orbitolites* and a *Cycloclypeus*, only inferior in size to those dredged by Sir E. Belcher on the coast of Borneo, my specimen being one inch and three-quarters in diameter.

On a small island in Haitan Straits, on the coast of China, I met with five species. One of these I have already alluded to as having also occurred in the Pescadores. Of the remaining four, found upon a promising stony beach at spring tide, one was a large velvety-brown *Doridopsis*, the second a small *Euplocamus*, or, perhaps, *Plocamophorus*, and the other two were richly coloured species of *Chromodoris*. Of these, one, studded with round crimson tubercles upon a cream-coloured ground edged with chrome, I afterwards found to be not uncommon at Labuan, not only on the shores of Labuan itself, but also on two small islands adjacent—another instance of rather more than twenty degrees of separation, nearly the whole of the China Sea being between the two localities.

On a submerged coral-reef, nearly in the centre of the China Sea, I found two species: one was probably a new species of *Chromodoris*, and the other a variety of the *Doris exanthemata* of Kelaart, described by him in the 'Annals' for 1859, among the Ceylon Nudibranchs. The specimen I obtained upon this reef was small, about 3 inches long, and by no means an ugly object; but upon a small coral-island on the west coast of Borneo, $7\frac{1}{2}$ degrees south of the reef, I again met with this species—this time, however, much larger specimens, nearly 7 inches long and $4\frac{1}{2}$ wide, which were truly wretched-looking objects for Nudibranchs, and much more like the "loathsome diseased mass" described by Kelaart.

When I was at Labuan, on showing some of my drawings of the above Nudibranchs to a gentleman who had indulged in shell-collecting on the reefs, I was assured that many beautiful species of the family were to be found there; and I therefore was greatly in hopes of adding largely to my collection at this place. The first species which occurred to me was,

singularly enough, the *Chromodoris* which I had already found at the Pescadores; the next I recognized as an old acquaintance of Haitan Straits, and I began to think there was nothing new—in Labuan at least; but I ultimately discovered a new species of *Doris*, beautifully marked with longitudinal lines alternately nearly black and white, the tentacles and branchiae being also mottled to match this colouring, the whole mantle and foot having a border of orange. This species was at that season of the year (August) pretty common; and I found it at Labuan, and also on both the small adjacent islands before mentioned.

The gentleman who had described to me the appearance of certain species which he averred having seen in his shell-collecting rambles, kindly accompanied me to the spot; and we both searched in every direction, but without success, and I was obliged to leave them to my successors to discover and bring to light. Probably it was not the right season. Upon one of the small islands I met with a large mottled-grey and tuberculated Dorid, 4 inches long, with capacious tentacles and expansive gill-tufts (not unlike *Doris tuberculata*), which exhibited a singular habit. Several specimens which I took home for examination, after a short time performed a spontaneous amputation of the mantle close round the body, as cleanly as if done with a pair of scissors, after which they soon decayed. At first I was inclined to attribute this circumstance to a large *Pyrgula*, which was in the same vessel; but having removed the other specimens into a separate vessel of clean water until I should have time to attend to them, I found the next day that they also had amputated their mantles. It appeared indeed to be a suicidal act, produced probably by the fouling of the water, and analogous perhaps to the breaking-up of *Comatulæ* and the self-evisceration of *Holothurice*.

At Singapore I found a variety of *Doridopsis rubra*, a fine rose-coloured species which occurs among the Ceylon Nudibranchs of Kelaart, and also among the Madras Nudibranchs described by Messrs. Alder and Hancock, and is perhaps synonymous with a Cuvierian species, *Doris solea*. It is not a little curious and interesting to find such small and delicate animals existing in places separated by so many hundreds (and, in some instances, thousands) of miles of trackless ocean; and there seems scarcely any limit to the geographical range of these creatures, which evidently require abundant food, whose locomotive powers are very limited, and whose soft bodies are ill calculated to resist much rough treatment by the waves. Probably their dispersion has mainly been effected by their multitudinous ova; and yet in many cases their

ribands of spawn are fixed to stones and rocks, and comparatively rarely to substances which could be easily transported by the waters. Although indeed we may be acquainted with or may easily imagine numerous methods of dispersal and distribution, there must evidently be many others we do not dream of, which are nevertheless common and effective.

I need hardly add that I have careful drawings, as well as specimens, of all the above-mentioned species of Nudibranchiata, which I hope to be able to publish at some future day. They have already (the drawings at least) had the advantage of being inspected by Mr. A. Hancock, who has kindly given me some valuable hints concerning them.

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XV.—*Remarks on the Names applied to the British Hemiptera Heteroptera.* By FRANCIS P. PASCOE, F.L.S. &c.

MESSRS. DOUGLAS and SCOTT having kindly undertaken to prepare for the Entomological Society a list of British Hemiptera, I should like to make a few observations on the names adopted by them, or rather on the principles which led to their adoption, in their well-known work*. In no other order of Insects is there so great a discrepancy in the nomenclature—Fieber, Flor†, Dallas, Bärensprung, Dohrn, and others agreeing only to differ. It will therefore be useful, I think, to examine the causes which, to a certain extent, have led to this result. The study of the Hemiptera is limited at present to comparatively few entomologists; and until "unnecessary genera" shall have been ignored by common consent, no uniformity can be hoped for. Putting this cause aside as one that will gradually disappear, there remain two faulty principles at work, and, singularly enough, among hemipterologists only, viz.:—(1) the application of the generic names of the older authors to obscure, sometimes extra-European species, instead of to the larger number of better-known species which those authors must have had most prominently before them, thus rendering the use of new names necessary; and (2) giving new names to such genera as were formed by the union of two or more genera of a preceding writer.

As an example of the first of these principles, we will take the old name of *Cimex*, under which Linnæus was content to

* The British Hemiptera, vol. i.: Hemiptera-Heteroptera. 1865 (Ray Society).

† I have not quoted this author because he uses a trinomial nomenclature which is rather difficult to explain.

include all the Hemiptera Heteroptera known to him, putting *C. lectularius* at their head. Fabricius, who seems to have delighted in capricious changes, then applied it to various forms of Scutelleridæ, Pentatomidæ, &c., Fieber eventually retaining it for *Pentatoma vernale* and its allies *prasinum* and *dissimile*: but it is rejected altogether by Messrs. Douglas and Scott as well as by H. H. Dohrn, Flor, and Bärensprung. In its old classical sense, as Linnæus doubtless intended it, it keeps its place in the works of Latreille, Westwood, Blanchard, Gerstaecker, and apparently in most authors conversant with general entomology. With one exception, that can be satisfactorily accounted for and need not be explained here, there is not a single Linnean genus, so far as I know, in the whole animal kingdom, that has not been adopted by zoologists; and the rule has been, apparently, to take the best-known species, which have been generally the commonest, as the types of the illustrious Swede. Why the Fabrician name *Acanthia** should have been preferred, it is difficult to say, seeing that species belonging to various modern genera are included under it, and therefore that it is as indefinite (if that be the objection) as the Linnean *Cimex*. In the same way *Cydnus*, Fab., has been discarded entirely by Messrs. Douglas and Scott, who refer the single British species retained under that name by Dr. Fieber to *Sehirus* of Amyot and Serville, who in their turn get rid of *Cydnus* by applying it to an obscure Indian insect. Again, Mr. Dallas, in his British Museum List, gives the name of *Æthus* to the *Cydnus* as understood by Fieber, and applies *Cydnus* to another genus—*Brachypelta*. Dr. Gerstaecker takes *C. morio* as the type, a species placed by Fieber under *Sehirus*, and by Bärensprung, who adopts the latter genus, under *Cydnus*: the difference between the two genera cannot be very great; and *Sehirus*, therefore, may as well sink. *Tetyra*, another Fabrician genus, is converted into *Eurygaster* by Dr. Fieber, who is followed by Messrs. Douglas and Scott: Drs. Gerst-

* Looking a little further into this genus *Acanthia*, we find that Fabricius proposed it in 1794 in his Ent. Syst., *Cimex lectularius*, the first species, being followed by forty-four more; in 1803, in his Syst. Rhyng., he confines it to two species, the first keeping its place and a new one added, the rest being dispersed. But in 1796, Latreille, in his Précis de Caract. &c., had so defined the genus as to limit it to the species for which Fabricius afterwards proposed the name of *Salda*. Furthermore, Latreille, in his Hist. Nat. des Crust. et des Ins. (published in 1802), redescribes the genus, giving *Acanthia sosteræ* (Fabricius's second species in the Ent. Syst.) as the type, leaving the first as the true type of *Cimex*. In this he was followed by Germar, Curtis, and Westwood, *Salda* to them being a synonym of *Acanthia*. It would be increasing the confusion if it were now attempted to restore *Acanthia* to the place to which its priority entitles it; the best that can be done is to drop it altogether.

aecker and Bärensprung, as well as Prof. Westwood, adopt the older name, with *T. maura* as the type. *Asopus*, Burmeister (a collective name for genera not otherwise admitted by its author), having for its type the well-known *Zicrona cærulea*, is limited by Dr. Fieber to one of the three species forming Hahn's genus *Arma*—*A. lurida*; by Bärensprung it is applied to *Cimex punctatus*, Linn. (*Rhacognathus*, Fieb.), a British species, and by Dohrn to two extra-European forms. Fieber, in his generic table, uses the word "*Podisus*," which would have been unobjectionable if the genus (which is very slightly differentiated from *Arma* by the comparative length of the joints of the antennæ) is to stand; it does not, however, seem likely to do so.

As examples of the second principle, I may mention the following:—1. *Hypnophilus*, a new name for the combined genera *Macrodera* and *Ischnocoris*, neither of which appears to be satisfactorily differentiated from *Pterometus*, Amy. & Serv.; indeed Dr. Dohrn (erroneously, I think) includes them under *Rhyparochromus*. 2. *Lopomorphus*, combining *Acetropis* (in pt.) and *Leptopterna*, Fieb. 3. *Litosoma*, a collective name for four of Fieber's genera. 4. *Sphyracephalus* (since changed, the name having been preoccupied) for two more genera. 5. *Idolocoris*, the same. It would also be satisfactory to know why Mr. Scott's *Monosynamma* was discarded for *Neocoris*, and *Macrophysa*, Westw., was rejected for the later name of *Zygonotus*. Whether *Allocladus* and *Halticus* should be changed because of a prior *Allocladus* and *Haltica*, respectively, is a matter of opinion; if the objection is a valid one, then numerous changes in all branches of natural history are inevitable—the change of three at least of Messrs. Douglas and Scott's above-mentioned genera among them (*Hypnophilus*, *Litosoma*, and *Neocoris*).

Another most unaccountable perversity is the substitution by so many entomologists of *Hydrometra* for *Gerris*. The latter name was first used by Fabricius in 1794 (Ent. Syst.); in 1796 Latreille, in his 'Précis,' separated one of the species (*Cimex stagnorum*, Linn.) under the name of *Hydrometra**; and this genus was afterwards more systematically treated in his 'Histoire' (1802). But in 1803 Fabricius (Syst. Rhyng.) quietly appropriates this name for the greater part of the species which he had formerly placed under *Gerris*, the latter being reserved for a few, mostly exotic† species. He still,

* *Gerris* is very clearly separated (*inter alia*) from *Hydrometra* by the "four posterior legs long, the anterior short" (p. 86).

† One common European species (now *Hæcarea vagabunda*) was retained in the altered condition of *Gerris*, and, according to the general rule alluded to above, this was considered by Burmeister to represent the true *Gerris*.

however, saw no objection to keeping two forms so very distinct (Fieber refers them to different families) as *Hydrometra stagnorum* and his old *Gerrides* in the same genus and thus entirely ignoring Latreille's more critical acumen, although he was perfectly aware of the fact, as he adds, under *Hydrometra stagnorum*, "*Hydrometra* Latr. Ins." Dr. Fieber quotes *Hydrometra*, "Fab. S. R. Gen. 37," *Gerris* being added as a synonym, which it certainly is not if the "S. R." is to be also quoted for it. In the midst of all this most unnecessary confusion, Dr. Burmeister slips in with a new name (*Limnobates*) for this *Cimex* = *Gerris* = *Hydrometra stagnorum*. If anything like a law of priority is to be retained, *Hydrometra* must be confined to *H. stagnorum*, *Gerris* reverting to its original members; and this may be said for other names besides those mentioned in these remarks, but which, as they do not apply to British species, need not be examined here.

XVI.—Notes on the Sexes of the *Cocytus* Group of the Genus *Adolias*. By A. G. BUTLER, F.Z.S.

SINCE writing my remarks upon *Cocytus* and its allies, I have made a rather important discovery as regards the sexes of some of the species of *Adolias*.

Dr. Felder (Wien. ent. Monatschr. v., December 1860) has described the male of Moore's *A. Puseda*; at the end of the description he adds the following observation:—"Auctor hujus speciei fœminam tantum cognovit et propter signaturas in sectionem *A. palunga*, *pulasaræ* &c. palpis distinctissimam locavit. *A. Cocytus* Fabr. proxima autem ejus affinis est." Moore should, however, have placed the *Cocytus* and *Ambalika* groups together, the former being the males of the latter.

I had previously separated the sexes, both male and female, as being possibly distinct species; and now that I have been enabled to match them, I find that in almost every case we received the opposite sexes together, and from the same collections; a comparison of the underside markings shows similar modifications of pattern in both sexes. The following alterations will therefore have to be made in this genus:—

1. ♂. *Adolias Cocytus*, Fabricius.

♀. *Adolias Gopia*? var., Moore.

Siam (Fabr.); Assam. ♂ ♀, B.M.

in its, for the second time, contracted sense. Except for this what is now with all entomologists a synonym, *Gerris* would disappear with these authors altogether from the European list.

2. ♂. *Adolias Blumei*, Vollenh.

♀. *Adolias (ambalika)*, var., of Moore).

Borneo, ♂ ♀, B.M.

3. ♀. *Adolias puseda*, Moore.

♂. *Adolias Cocyta*, Fabricius.

Singapore; Penang; East Indies. ♂ ♀, B.M.

The opposite sexes of the following known species may be characterized as follows:—

4. *Adolias ambalika*, Moore.

♂. Alæ supra obscure fuscæ; anticæ paulum falcatæ, maculis obsoletis subviolaceis discoideis a lituris consuetis nigris limitatis; margine externo anali cæruleo, violaceo tincto: posticæ area externa ad cellam fere cærulea, violaceo tincta; apice roseo tincto; margine ipso tenuissime nigro, ciliis niveis.

Alæ subtus ochraceæ: anticæ lineis consuetis discoideis nigris, stria media undata pallide fusca angulari, altera discali obscuriore obliqua sexmaculari: posticæ lineis nullis discoideis; striis duabus discalibus approximatis indistinctis undatis fuscis.

Exp. alar. unc. 2½.

♀. *A. ambalika*, Moore, Trans. Ent. Soc. (1859) p. 74, pl. 5. fig. 3.

Collected by H. Lowe. Borneo. ♂ ♀, B.M.

5. *Adolias Diardi*, Vollenhoven.

♂. Alæ supra fere velut in *A. Blumei* Voll. ♂, sed paulum breviores. Alæ subtus olivaceo-ochraceæ: anticæ area interna et macula apicali violaceis: posticæ lineis consuetis discoideis, lineis discalibus magis approximatis et velut in fœmina dentatis; aliter velut in *ambalika* ♂.

♀. *A. Diardi*, Vollenhoven, Tijdschrift voor Entomologie (1862), p. 188. n. 8, pl. 10. fig. 2.

Collected by Capt. Brooke. Borneo. ♂ ♀, B.M.

2 a. *Adolias Blumei*, Vollenhoven.

♂. *A. Blumei*, Vollenhoven, Tijdschr. voor Ent. (1862), p. 204. n. 30, pl. 12. figs. 3, 4.

♀. Alæ magnæ, supra fuscæ, velut in *ambalika* ♀ fere scriptæ, maculis albis autem fusco nebulosis; disco subanali anticarum et disco medio posticarum velut in *Gopia* ♀ cæruleo tinctis.

Alæ subtus velut in *A. Diardi* fere scriptæ sed multo obscuriores; area externa fusca, maculis posticarum multo magis regularibus, et ad angulum ani violaceo paulum tinctis.

Exp. alar. unc. 3½.

From two different Collections. Borneo. ♂ ♀, B.M.

6. *Adolias cocytina*, Horsfield.

♂. *A. Cocytina*, Horsfield, Zoological Journal (1855), p. 67, pl. 4. figs. 3, 3a.

♀. Alæ supra velut in *A. Gopia scriptæ*; minores, maculis discalibus anticarum albis fusco magis tinetis, posticarum punctiformibus.

Alæ subtus magis ochraceæ, maculis inferioribus discalibus anticarum magis elongatis; serie macularum in posticis magis ad marginem approximantibus; aliter velut in *A. Gopia* ♀.

Purchased of Mr. Stevens. Sumatra. ♂ ♀, B.M.

XVII.—*Observations on Sea-Bears (Otariadæ), and especially on the Fur-Seals and Hair-Seals of the Falkland Islands and Southern America.* By Dr. J. E. GRAY, F.R.S., V.P.Z.S., F.L.S. &c.

THE Sea-Bears (*Otariadæ*) inhabit the more temperate and colder parts of the southern hemisphere, and the temperate and more northern regions of the Pacific Ocean.

Navigators, from the general external resemblance of the animals, have regarded the Sea-Lion and Sea-Bear of the northern and southern regions as the same animal. Pennant (who paid considerable attention to Seals) and most modern zoologists did the same.

Nilsson, in his excellent Monograph of the Seals, only mentions three species of Eared Seal:—1. *Otaria jubata*, 2. *O. ursina*, and 3. *O. australis*. He believed that the first was common to the Falkland Islands, Chile, Brazil, New Holland, and Kamtschatka, and the second to Magellan's Straits, Patagonia, New Holland, and the Cape. We now know that the species have a very limited geographical distribution.

When I published my 'Catalogue of the Seals in the British Museum,' in 1850, I was satisfied from Steller's description that the species he described from the arctic regions were distinct from those found in the southern seas; and when I at last succeeded in obtaining specimens and skulls from the northern regions of the Pacific, I not only found that my idea was confirmed, but that they did not even belong to the same genera. I had the skulls of these species figured in the 'Proceedings of the Zoological Society' for 1859, and thus greatly extended the knowledge of the animals. But there is yet much to be learnt respecting them. We do not know the species of Fur-Seal described by Forster as inhabiting the coast of New Zealand.

As a proof of how little the Eared Seals or Sea-Bears were formerly understood, we have only to refer to Fischer's 'Syn-

opsis,' where, after quoting the description of Forster's Sea-Bear in Cook's Voyage, and his figures in the Supplement to Buffon, vi. p. 536, t. 47, Fischer adds, as a note, "An non potius generi *Enhydria* adnumeranda?" (see p. 232).

The skull of these animals changes so much in form as the animal arrives at adult and old age, that it is not always easy to determine the species by it, unless you have a series of them, of different ages and states, to compare. Thus Dr. Peters, in his revision of the genus after the publication of my Catalogue and figures of the skulls in the 'Voyage of the Erebus and Terror' and in the 'Proceedings of the Zoological Society,' formed no less than five species from the skulls of the southern Sea-Lion (*Otaria jubata*)—*O. jubata*, *O. Byronia*, *O. leonina*, *O. Godeffroyi*, and *O. Ulloa*,—referring the first four to the subgenus *Otaria*, and the last to *Phocarcos* (see Monatsbericht, May 1866, pp. 265, 270). In his second essay, published a few months later (*ibid.* Nov. 1866), after his visit to London, he placed them all together in one subgenus (*Otaria*), and seems, by the way in which he has numbered four of them, to doubt their distinctness. It would have been better if he had at once simply reduced them to synonyms (as they must be reduced) and included with them *O. Ulloa*, which is only the skull of a young specimen, such as was called *O. molossina*, Lesson & Garnot. I may observe that I had shown in my first 'Catalogue of Seals' (1850), from the examination of the typical skull, that two or three of these nominal species were only very old or young skulls of the southern Sea-Lion.

It is the character of the Eared Seals or *Otariadæ* to have a very close, soft under-fur between the roots of the longer and more rigid hairs. They are therefore called *Fur-Seals* by the sealers, and are hunted for their skin as well as for their oil. The quantity and fineness of the under-fur differ in the various species; and the skin and under-fur bear a price in the market according to the country and the species from which they are obtained.

Some species of the family have so little under-fur when they arrive at adult age, that they are of no value in the market to be made into "seal-skins;" these are therefore called *Hair-Seals* by the sealers. They are only collected for the oil, as the skins are of comparatively little value.

The skins of the Fur-Seal are much used in China, and are more or less the fashion in this country, sometimes being far more expensive than at others. The skins of the Hair-Seals are only used, like the skins of the Earless Seals or *Phocidæ*, for very inferior purposes, as covering boxes, knapsacks, &c.; but the animals are much sought after for the oil they afford.

The furs of the different species of Fur-Seals are exceedingly different in external appearance, especially in the younger specimens, or when the fur is in its most perfect condition. In most species the hairs are much longer than the under-fur; they are flat and more or less rigid and crisp. In others the hairs are short, much softer, scarcely longer than the soft woolly under-fur; in these species the fur is very dense, standing nearly erect from the skin, forming a very soft elastic coat, as in *O. falklandicus* and *O. Stelleri*. The hair of *O. nigrescens* is considerably longer than that of *O. cinerea*, but not so harsh, the fur of the half-grown *O. nigrescens* being longer, sparse, flat, rather curled at the end, giving a crispness to the feel; while the hairs of the very young specimens are abundant, nearly of equal length, forming an even coat that is soft and smooth to the touch.

Difficult as it is for the zoologist to distinguish the species by their external appearance, the skins of the different species of Fur-Seals are easily distinguished by the dealers, even when they are wet, showing that the practical fellmonger is in advance of the scientific man in such particulars, as the dealers in whalebone were in regard to the distinction of the species of whale by their baleen (see Zool. Erebus & Terror).

At the Dyster, Nalden, & Co. public sale of Cape Fur-Seals they are subdivided into large, middling, and small "wigs" (these are males with a mane), "middlings" and "small" (females and young males), large, middling, and small "pups" (these are half-grown), and black "pups" (very young animals). They are imported salted in casks.

The longer hairs of the Fur-Seals are very slender and pale-coloured at the basal half of their length, and thicker and darker at the upper half, and often have a white tip. The basal half is subcylindrical, the upper half is flat, tapering at each end. The absolute length of the hairs and the length as compared with the length of the under-fur differ in the various species. Judging from the old and young specimens of *A. nigrescens*, the hairs seem to be longer, both absolutely and relatively to the under-fur, in the young than in the adult animals. The hairs of the Hair-Seal are shorter, flat, channelled above, and gradually tapering from the base to the tip, merely contracted at the insertion into the skin. The breadth of the hairs seems to vary in the different species; and in the younger specimens there are to be observed some soft hairs like the under-fur of the Fur-Seals.

The Falkland Islands is a sealing-station, and is the home of several species, the southern Sea-Bear (*Otaria jubata*) and a Hair-Seal (*O. Hookeri*) being found there, as well as the

two Fur-Seals for which the "fishery" is chiefly established. Capt. Abbot says that the Fur-Seals of the Falkland Islands are of various colours—some grey, others blackish. There are in the British Museum two most distinct species of Fur-Seal from the Falklands, which must be of very different value,—one the *Otaria falklandica* of Shaw, and the other *O. nigrescens*.

All the five species of Sea-Bears or Eared Seals found in South America have been called *O. falklandica*. I will proceed to distinguish them.

I. Pennant describes the "Falkland-Island Seal," from a specimen 4 feet long, in the museum of the Royal Society, thus:—"Hair short, cinereous, tipped with dirty white;" "grinders conoid, with a small process on one side near the base." It is to this description that Dr. Shaw applied the name of *Phoca falklandica* (Gen. Zool. i. 256). This agrees with a specimen in the Museum in all particulars. It certainly is not the dark blackish-brown Seal which I have described as the *Arctocephalus nigrescens*, and which Dr. Peters calls *O. falklandica*.

A specimen of a Seal about 3 feet long has been in the British Museum for several years. It was obtained from a dealer as a Fur-Seal from the Falkland Islands. This skin is mentioned in the 'Catalogue of Seals in the British Museum,' at page 43, as *Arctocephalus falklandicus*, or "the skin of an adult female without skull," believing that it was similar to the specimen of the Falkland Seal that was in the Leverian Museum, described by Pennant as above quoted, to which description Shaw appended the name of *Phoca falklandica*.

Mr. R. Hamilton, in the 'Annals of Natural History' for 1838, vol. ii. p. 81, t. 4, gives a history of the Fur-Seal of commerce and an account of the catching of them. He deposited two female specimens of this Seal in the Museum of the University of Edinburgh. He says the two specimens are nearly alike in every respect, and describes them thus:—"The hair is very soft, smooth, and compact, of a brownish-black colour towards the roots and a greyish-white towards the tips; it extends considerably beyond the fur, and gives the general colouring to the hide. The fur itself is uniform brownish white above, and of a somewhat deep brown colour beneath, and is quite wanting on the extremities. The colour of the body is of a uniform whitish grey above, passing gradually underneath into a reddish-white colour, which is deepest in the abdominal region." This is certainly the *Falkland Seal* of Pennant. Capt. Weddell says that the males of the Fur-Seals are much larger than the females, an adult male measuring 6½ feet, and the female not more than 3½ feet in length.

1. *Arctocephalus falklandicus*.

Fur very soft, elastic; hairs very short, exceedingly close, slender at the base, thicker above, with close reddish underfur nearly as long as the hair; the upper surface pale, nearly uniform grey, minutely punctulated with white; hairs brown, upper half black, with minute white tips. The nose, cheeks, temples, throat, chest, sides, and underside of the body yellowish white.

Falkland Seal, Penn. Quad. ii.

Phoca Falklandica, Shaw, Gen. Zool. i. p. 256 (from Pennant).

Otaria Falklandica, Desm. Mamm. 252 (from Pennant; not Peters or Burmeister).

Otaria Shawii, Lesson, Dict. Class. d'H. N. xiii. p. 424 (from Pennant).

Arctocephalus Falklandicus, Gray, Cat. Mamm. in Brit. Mus., Seals, p. 42.

Fur-Seal of commerce (*Otaria falklandica*), Hamilton, Ann. & Mag. Nat. Hist. 1838, ii. p. 81, t. 4; Jardine, Nat. Lib. vi. p. 271, t. 25 (not Peters).

Hab. Falkland Islands. Brit. Mus.

This is a most distinct species, and easily known from all the other Fur-Seals in the British Museum by the evenness, shortness, closeness, and elasticity of the fur, and the length of the under-fur. The fur is soft enough to wear as a rich fur, without the removal of the longer hairs, which are always removed in the other Fur-Seals. Unfortunately the specimen is without any skull; and therefore I cannot give a description of the teeth, or refer it to any of the restricted genera of *Otariadæ*.

In the British Museum there is a skull of a young *Arctocephalus* (No. 311 a) like the skull of Capt. Abbot's specimen, but in a much younger state. It was presented to the Museum by Sir John Richardson as the "skull of the Fur-Seal from the Falklands." The teeth in the skull belonging to Capt. Abbot's skin are much larger than they are in the one received from Sir John Richardson. The fifth or last grinder in the series of the lower jaw, that was being developed, but which had not yet cut the gums or been raised above the alveolus, is divided into three lobes, the middle lobe being the largest and most external, the lateral ones being on the inner side of it. In Sir John Richardson's specimen, the same tooth in the lower jaw is triangular, compressed, with regular, sloping, sharp-edged sides, and has only a small lobe on the lower part of the hinder edge, which is on the same plane as the rest of the tooth. It looks like the skull of a large species. The tentorium of this skull of a young animal is well developed and bony. If the habitat assigned to this skull is the correct one (and I have no reason to doubt it), it is probably the skull of a very young *Arctocephalus falklandicus*, with the grey back and white underside: it is certainly not the skull of *A. nigrescens*.

Cuvier (Ossem. Fossiles, v. p. 220) describes an Eared Seal, purchased of M. Hauville, of Havre, as coming from the Falkland Islands, thus:—"Elle est longue de quatre pieds deux pouces, d'un cendré en dessous, blanchâtre aux flancs et sous la poitrine, une bande d'un brun rouge règne le long du dessous du ventre et une bande noirâtre va transversalement d'une nageoire à l'autre." It has been called *Otaria Hauvillii* (Lesson, Dict. Class. xiii. 425) and *Phoca Hauvillii* (Fischer, Syn. Mamm. 254). Cuvier adds that this specimen has been indicated by M. de Blainville (Journ. de Phys. xci. p. 298) under the name of *Otarie de Péron*. This animal is probably the same as the one mentioned by Pennant, and in the British Museum. The streaks on the lower part of the body were probably only an accidental or individual variation. The specimen in the British Museum is uniform white below, without any indication of a longitudinal streak or cross band.

II. The British Museum contains the skin and skull of a large blackish Eared Seal, nearly 6 feet long, that was purchased of a dealer as "a Fur-Seal from the Falkland Islands;" but, as the dealers seem always to give that as the habitat for all the seal-skins with a distinct under-coat that come into their possession, I have quoted the habitat with doubt. When occupied in describing the Seals of the southern hemisphere for the 'Voyage of the Erebus and Terror,' I named this Seal *Arctocephalus nigrescens*, and had the skull figured under that name; but the plate has not yet been published, though copies of it have been given to Dr. Peters and other zoologists. In the 'Proceedings of the Zoological Society' for 1859, pp. 109, 360, and in the 'Catalogue of Seals and Whales,' I described the skull of this species. There is also in the Museum a skull of a younger animal of the same species.

Capt. Abbot, in 1866, sent to the British Museum a large and a small Seal from the Falkland Islands. The large one was examined and determined to be the Southern Sea-Lion (*Otaria jubata*). The small one, nearly three feet long, was very similar in external appearance; and as the teeth, which could be seen without extracting the skull, showed that it was a young animal, it was regarded as the young of the Sea-Lion, and it was stuffed without extracting the skull, and labelled as such. This specimen has been examined by several zoologists, among the rest by Dr. Peters, when engaged with his paper on Eared Seals, and has passed unchallenged until this time, thus showing how difficult it is to distinguish these animals by their external characters alone. Capt. Abbot, who is now residing in England, informed me that the smaller specimen was the

Fur-Seal of the Falkland Islands, that it grows to about half as long again as the specimen sent, and that the old males are grey from the tips of the hairs. I have therefore had the skull extracted from the specimen; and there is no doubt that it is quite distinct from the Sea-Lion (*Otaria jubata*); and, on more careful examination of the skin, I have little doubt, from the colour and the character of the fur, that it is a young specimen of the Seal that I described as *Arctocephalus nigrescens*. It is interesting as confirming the accuracy of the habitat that I received with that specimen, and which until this time I considered doubtful, as Pennant and others describe the Falkland-Island Fur-Seal as grey, and white beneath. Capt. Abbot's young specimen chiefly differs from the adult one in the Museum in the hairs being longer, more erect, and with minute white tips, and in the face, throat, and chest being rufous brown; but this reddish colour is common to the young of several Sea-Bears.

Dr. Peters, on the authority of this habitat (which I have always quoted with doubt), has given the name of *Arctophoca falklandica* to the animal and skull on which I established my *Arctocephalus nigrescens*.

In the British Museum there is the skin of a very young Seal which was presented by Sir John Richardson as the Falkland-Island Fur-Seal, with the observation appended that the adult is 5 feet long, and its skin is worth fifteen dollars. It is without its skull. The fur of this young Seal is dark brown, reddish beneath, and very like that of the young specimen sent by Capt. Abbot; but the hairs are smoother, and the white tips to them are longer and more marked, giving the animal a more grizzled appearance.

There is another young Eared Seal, very like the former, which was received with General Hardwicke's collection (who, no doubt, purchased it of a dealer), said to have come from the Cape of Good Hope. I suspect this habitat must be erroneous; for it is very unlike what I recollect of the young of the Cape Eared Seals, which are called "Black Dogs," on account of the blackness of their colour. Unfortunately we have no specimen of the latter in the Museum Collection. General Hardwicke's specimen only differs from Sir John Richardson's in being less punctulated with white; fewer hairs have a white tip, and the tip is shorter.

Both these young specimens differ from the half-grown one obtained from Capt. Abbot in the fur being softer and smooth to the touch; and Capt. Abbot's specimen differs from the adult in the length and greater crispness of its fur, the fur of the old one being harsh and hard and closer pressed.

2. *Euotaria nigrescens*, Gray,

Ann. & Mag. Nat. Hist. 1866, xviii. p. 236.

The synonymy of this species will be—

Arctocephalus nigrescens, Gray, Zool. Erebus and Terror, t. ; P. Z. S. 1859 pp. 109, 360; Cat. Seals and Whales, p. 52; Gerrard, Cat. of Bone. p. 147.*Arctocephalus (Euotaria) nigrescens*, Gray, Ann. & Mag. Nat. Hist. 1866, xviii. p. 236.*Otaria (Arctocephalus ?) Falklandica*, Peters, Monatsb. 1860, p. 273.*Otaria (Arctophoca) Falklandica*, Peters, Monatsb. 1860, p. 671.*Hab.* Falkland Islands, Volunteer Rock (Capt. Abbot).

In the first essay, Dr. Peters places *Phoca falklandica*, Shaw, and *Otaria nigrescens* together, with doubt, observing that one was known from the skin and the other by the skull, overlooking the fact that the name *nigrescens* implied that I had seen the colour of the fur, which was not that given by Shaw to his animal; in his second essay, Dr. Shaw's, Dr. Burmeister's, and my animal are all classed together without any doubt.

The skull of Capt. Abbot's Fur-Seal from the Falkland Islands shows that it was a very young animal, which had only developed its first grinders, the permanent series being developed below them. The tentorium is bony and well-developed. The teeth are the same in position and number as they are in the adult skull; and the upper ones, as far as developed, are small and conical, except the fifth upper grinder, which is largest, triangular, with a single subconical lobe on the base of the hinder edge of the cone. The lower canines are small, scarcely larger than the cutting-teeth, which are nearly uniform in size. The lower grinders are of a much larger size than the upper ones in the adult skull, as if they belonged to the permanent series: they are of the same form as the teeth in adult skulls; but the central cone is higher and more acute, and the anterior and posterior lobes at the base of the cone are more developed and acute, the lobes of the last or fifth grinder being larger and rather on the inner surface of the tooth.

The skull of Capt. Abbot's animal is evidently not the same as the skull of a young Eared Seal described and figured by Dr. Burmeister as the skull of *Arctocephalus falklandicus* from the mouth of the Rio de la Plata, in the Ann. & Mag. Nat. Hist. ser. 3. vol. xviii. p. 99, t. 9, which, from the appearance of the grinders, I suspect is the young skull of *Phocarcctos Hookeri*, the Hair-Seal of the Falkland Islands.

There is a considerable difference in the proportions of the skull sent by Capt. Abbot from those of the one figured by

Dr. Burmeister. In Capt. Abbot's specimen the brain-case from the back edge of the orbit to the occiput is as long as the length of the face from the same edge of the orbit to the end of the nose. In Dr. Burmeister's figure, the face from the same point is much longer than the brain-case.

III. On the return of the 'Erebus' and 'Terror,' the British Museum received from the Lords of the Admiralty several skins of a Hair-Seal from the Falkland Islands and the Antarctic Sea, of a brownish-grey colour and paler beneath, which I described under the name of *Arctocephalus Hookeri*, and figured the skull. Unfortunately we had no very definite habitat for some of the specimens. All the skins were preserved in salt.

3. *Phocarcos Hookeri*, Gray,

Ann. & Mag. Nat. Hist. 1866, xviii. p. 234.

Fur brown grey, slightly grizzled, pale, nearly white beneath; hairs short, close-pressed, rather slender, flattened, black, with whitish tips, the tips becoming longer on the under part of the sides; feet reddish or black; whiskers black or whitish.

Young pale yellow, varied with darker irregular patches; length 18 inches. B.M.

Arctocephalus Hookeri, Gray, Zool. Erebus and Terror, t. 14, 15 (skull); Cat. Seals B. M. p. 45. f. 15; P. Z. S. 1859, pp. 109, 300; Cat. Seals and Whales, B.M. p. 54.

Arctocephalus Falklandicus, Burmeister, Ann. & Mag. N. II. 1803, xviii. t. 9. f. 1, 2, 3, 4 (skull only).

Young or albino? entirely cream-coloured, about 2 feet long.

Eared Seal, Pennant, Quad. ii. p. 278.

Phoca flavesceus, Shaw, Gen. Zool. i. p. 290, t. 73 (from Pennant).

Hab. Falkland Islands.

Pennant, in his 'Quadrupeds,' describes an Eared Seal, rather more than 2 feet long, the whole body of which was covered with longish hair of a whitish or cream-colour; it was brought from the Straits of Magellan, and preserved in Parkinson's Museum on the south side of Blackfriar's Bridge (see "Eared Seal," Pennant's Quad. ii. p. 278). Dr. Shaw, in his 'General Zoology,' gave the name of *Phoca flavesceus* to this species, and figured it (i. p. 260, t. 73).

This is very probably the young of the Hair-Seal of the Falklands, described by me as *Arctocephalus Hookeri*, which is of a pale-yellowish colour. Pennant does not mention the want of the under-fur.

Dr. Burmeister observes:—"We have in the Museum [at

Buenos Ayres] a young half-grown specimen [of *Arctocephalus falklandicus*] nearly 3 feet in length. From this I have taken the skull, of which I send you a description and drawings." (Ann. N. H. 1866, xviii. p. 99, t. 9. f. 1, 2, 3, 4.) From the comparison of the figures, and especially of the teeth and the form of the palate, with our older skull of *Arctocephalus Hookeri*, I have little doubt that it is the skull of a specimen of that species before the grinders were all developed. It is not the skull of *Otaria jubata*, which the other specimen he called *A. falklandicus* is, as proved by the form and position of the hinder nasal openings. The figure of the young skull differs from the older skull of *A. Hookeri* in the British Museum in having a notch in the middle, while the older skull of *A. Hookeri* has a conical prominence in the same place. Such differences are found in skulls of Seals at different ages.

IV. In 1865, a French sailor named Leconte, serving on board the 'Paulina,' of Buenos Ayres, brought to England a young male Sea-Bear that was captured near Cape Horn, in the month of June 1862. A female he had obtained shortly afterwards had not survived to reach Europe. Having been previously shown in France, in England it was first exhibited in the Cremorne Gardens, Leconte having taught it several tricks, such as ascending a ladder, firing off a pistol, and sitting in his lap and kissing him, rewarding it for each of its tricks with a piece of fish. The animal was at length purchased by the Zoological Society, and Leconte retained to attend to it. It is well figured in the 'Illustrated London News,' the 'Boy's own Book,' and in the 'Proceedings of the Zoological Society' for 1866, p. 80.

The animal died in 1867; and Dr. Murie has undertaken to give an account of its anatomy, which I look for with much impatience, as I am not aware that the anatomy of the family has ever been given. Leconte has been sent by the Society to the Falkland Islands in hopes that he may bring to Europe some other Seals of the southern hemisphere.

When I first saw this Seal, on account of its short fur, dark colour, and yellow nape, I named it *Otaria jubata*; and it was so named for a time in the Zoological Gardens; afterwards Mr. Sclater determined it to be the *Arctocephalus Hookeri*, and figured it as such (P. Z. S. 1866, p. 80), overlooking the pale colour of the fur of that species.

Dr. Burmeister (Ann. Nat. Hist. 1866, xviii. p. 99) says the Sea-Lion (*Otaria jubata*) and *Arctocephalus falklandicus* are the only Seals "found in the Atlantic near the mouth of the Rio de la Plata. They were formerly common on the small

islands at the mouth of the river," the *Islas de los Lobos* (Islands of Sea-wolves). "They not unfrequently come up as far as Buenos Ayres, where I have twice seen full-grown living specimens of *A. falklandicus*. Both of these were, I believe, carried to France. . . . They were kept here for a long time in a large basin of fresh water; and I was one of the daily visitors to these very interesting animals.

"We have in the Museum a young half-grown specimen, nearly 3 feet in length." He figures the skull of this specimen, which is evidently the skull of a *Phocarcos Hookeri*.

The two living specimens mentioned are doubtless those which Leconte brought to Europe.

I have, since this paper was commenced, received the skull of the specimen that died in the Gardens, and find that it is a half-grown, rather stunted *Otaria jubata*, and may be thus described:—

Fur dark brown; cheeks, temples, and sides of forehead black; neck greyish brown; back of the neck yellow brown; belly dusky black. Hairs flat, tapering, dark brown, yellow, and whitish intermixed, without any under-fur.

The following synonyms may be added to those of the species in the 'Catalogue of Seals and Whales:—

Sea-Bear, Illustrated London News; Boy's Own Book.

Otaria jubata, Label in Zool. Gardens, 1805.

Otaria Hookeri, Selater, P. Z. S. 1806, p. 80 (figure, young male).

Arctocephalus falklandicus, Burmeister, Ann. Nat. Hist. 1806 (not skull).

Hab. Cape Horn (Leconte). Skin and skeleton, B.M.

This animal has the harsh fur without any under-fur of *Phocarcos Hookeri*; but it entirely differs from that animal in the colour of the fur. This cannot arise from the greater age of the animal, as it is not nearly so large as the half-grown *P. Hookeri* in the British Museum.

In the dark blackish-brown colour of the fur and the pale-brown colour of the nape, and in the absence of the under-fur, this Seal resembles the adult *Neophoca lobata* from Australia; but in that species the pale colour extends all over the crown, while in the young male *Otaria jubata* there are only a few paler scattered hairs on the middle of the crown and nose.

V. I must refer to another species of Sea-Bear which has been mixed up with the Fur-Seal of the Falkland Islands.

In the 'Monatsbericht,' May 1866, p. 276, t. 2. *a, b, c*, Dr. Peters described and figured with considerable detail a skull of a Sea-Bear (sent to the Berlin Museum by Dr. Philippi, who obtained it at Juan Fernandez Island) under the name of *Otaria Philippi*, forming for it a subgenus which he calls *Arctophoca*.

Ann. & Mag. N. Hist. Ser. 4. Vol. i.

In his revision of that paper, published in the same work for November 1866, page 671, he places it as a synonym or subspecies of what he calls *Otaria falklandica*, which is my *Arctocephalus nigrescens*, and not the *Otaria falklandica* of Shaw nor the *Otaria falklandica* of Burmeister as Dr. Peters supposes, as I have shown above. In this paper he removes *Otaria falklandica* (that is, *nigrescens*) from the subgenus *Phocarcos*, to which he referred it in his first paper, and places it in his subgenus *Arctophoca*.

I have not seen the skull; but I believe, from the figure, that this alteration is a mistake. The figure of the skull of his *Otaria Philippii* has no resemblance to the skull of my *Otaria nigrescens*. It is more nearly allied to the skull of *Otaria Stelleri* from California, agreeing with it in having a vacant space with a pit in the bone between the fourth and fifth upper grinders on each side, looking as if a grinder had fallen out and the cavity had been filled up.

The subgenus *Arctophoca* of Dr. Peters's first essay, not as modified in his second one to contain *O. falklandica* (*nigrescens*), chiefly differs from Gill's genus *Eumetopias*, which was formed on my description and figure of the skull of *Otaria Stelleri* (or *californiana*), in the fifth upper grinder not being so far back, but in a line with the back edge of the orbital process of the zygomatic arch, instead of far behind it as it is in *Eumetopias*.

XVIII.—On the Occurrence of *Diplommatina Huttoni* and *Ennea bicolor* in the West Indies. By WILLIAM T. BLANFORD, F.G.S., C.M.Z.S.

IN the 'Annals and Magazine of Natural History' for August 1867, Mr. R. J. Lechmere Guppy described the occurrence in Trinidad of *Diplommatina Huttoni*, Pfr., and suggested that its presence and that of *Ennea bicolor*, Hutton, might be accounted for by supposing both to have migrated across the Tertiary Atlantis. I cannot help thinking that there are several circumstances opposed to this view; and in order to explain them it is necessary to describe the distribution of *Diplommatina Huttoni* and *Ennea bicolor* in India.

Diplommatina Huttoni has hitherto only been found on the lower slopes of a portion of the Western Himalayas, near Masúri. It is true that the Himalayas have not been explored to a sufficient extent to justify the assertion that the shell does not exist elsewhere; but, as not a single Western Himalayan *Diplommatina* has as yet been found in those parts of the Eastern Himalayas about Darjiling which have been comparatively well explored, nor, *vice versa*, a solitary Darjiling species in the Western Himalayas, it is extremely improbable

that the range of *D. Huttoni* extends more than, at the outside, 200 or 300 miles along the base of the mountains. In the plains of India no *Diplommatina* has ever yet been found*. In the hills of Southern India, forms differing entirely from those of the Himalayas alone occur. The negative evidence, therefore, against the existence of *D. Huttoni*, or of any other Indian species of the genus, over any large area of country is overwhelming. And this is entirely in accordance, as has been remarked by Mr. Benson, with the general facts of the distribution of operculated land-shells in India, none being met with over so large an area as species of the non-operculated forms frequently are.

To the west of Hindustan not a single *Diplommatina*, or land-shell allied to *Diplommatina*, has ever been recorded. The genus and its allies are utterly unknown in Western Asia, Europe, and Africa. Not only are the Diplommatinidæ absent, but all their allies, the Cyclophoridæ, are equally so, with the exception of two or three obscure species in South Africa and of the anomalous genus *Craspedopoma* in the Azores, Madeira, and Canary Islands; and these few forms have at least as close an affinity to American types as to those of India.

To the east and south-east of India the case is different. Species of *Diplommatina*, many of them sinistral, and of allied genera have been found in Burma, Labuan (*Opisthostoma De-Crespignii*), the Philippine Islands (*Arinia*), the Moluccas, the Pelew Islands (*Palaina*), the New Hebrides, New Caledonia, Lord Howe's Island, Australia, and New Zealand. A species is said to occur also in the Sandwich Islands. Now, as *Megalomastoma* and *Cyclophorus* are common to the mainland of India, the Malay archipelago, and the West Indies, it appears by no means improbable that *Diplommatina* may have the same distribution; and certainly, if *D. Huttoni* ever migrated or was transported by natural causes from India to America, I cannot help thinking that it most probably traversed countries inhabited by its relations. But I cannot help doubting its having migrated at all over any extensive area.

Ennea bicolor is a shell of much wider distribution. It is met with throughout the whole peninsula of Hindustan, and it also occurs in Burma. It lives in the plains, in cultivated land as well as in waste.

It is easy to conceive that a mollusk with such habits might

* I know of but one, doubtful exception—doubtful inasmuch as I do not know at what elevation the shell was found. This was in South Canara, on the Malabar coast. The form was one of the type peculiar to the hills of Southern India. The whole fauna of the coast of Malabar is peculiar.

be very probably transported with living plants, or with roots or seeds. Mr. Guppy doubts whether the animals would survive the voyage from the East to the West Indies. Of this there can, I think, be no question. Mr. Benson, if I am not mistaken, has had specimens of *Diplommatina* alive in England; and there are very few Indian shells which, when aëstivating, will not bear a journey of several months without injury, provided damp or excessive cold be avoided.

That the introduction of a single pair of shells is ample for the diffusion of the species has been proved in Calcutta in the case of *Achatina fulica*. The facts are well known, but will bear repeating. About twenty-five years ago, two specimens were brought from Mauritius, and placed in a garden. Now the species abounds almost everywhere throughout an area of at least five miles in length. In many places several hundreds might be collected. Ten years ago, to my own knowledge, the shell was quite unknown in the Botanical Gardens on the opposite bank of the Hoogly. The other day I saw it living there in abundance. Of course, in a large city like Calcutta, where plants are constantly transferred from one garden to another at a distance, great facilities for dispersion exist; but the numbers, all unquestionably derived from a single pair in the course of so short a time, are nevertheless astonishing. I have very little doubt that one impregnated female would suffice equally well to introduce a species.

Another fact in favour of *Diplommatina Huttoni* and *Ennea bicolor* having been introduced into the West Indies by man is, that both are very small shells, precisely such as would most easily escape notice and be transported with plants. No shell is more likely than the *Ennea* to have been thus carried into foreign countries. The case of the *Diplommatina* is certainly far more difficult, but still it appears to me to present fewer difficulties than the theory of migration. Is there a botanical garden in Trinidad?

If the *Diplommatina* has not been transported artificially, I should be almost inclined to suspect that the Trinidad species is not really identical with that inhabiting the Western Himalayas, but that two forms, closely resembling each other, have originated separately at the extreme limits of the area occupied by the genus.

With regard to the *Ennea*, I have very little doubt of its having been transported. Many of the cultivated plants of the West Indies must have been introduced by the Spaniards and Portuguese, some of them, in all probability, direct from India; and the date of the introduction may thus have been sufficiently distant to allow of a considerable amount of dispersion amongst the various islands.

XIX.—On the Discovery of a new and gigantic Fossil Species of *Echidna* in Australia. By GERARD KREFFT, Curator and Secretary of the Australian Museum, Sydney.

To the Editors of the *Annals and Magazine of Natural History*.

GENTLEMEN,

In cataloguing the rich collection of Australian fossil remains in the Museum at Sydney, I observed, among other novelties, a fragment of the humerus of a gigantic *Echidna* (much larger

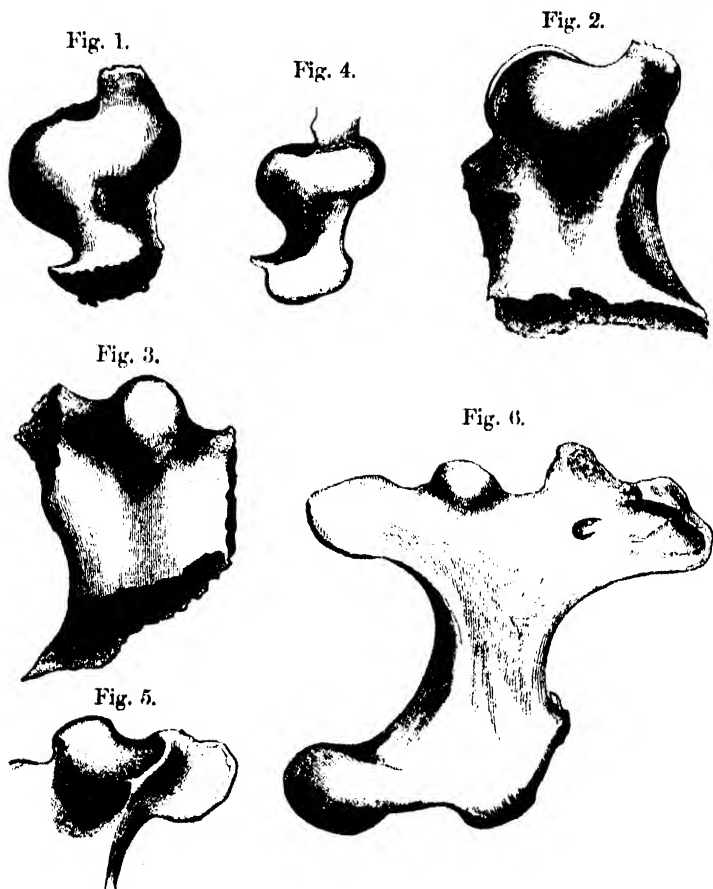


Fig. 1. Fragment of humerus of a fossil *Echidna*, view from above
 Fig. 2. Ditto, front view. Fig. 3. Ditto, back view.
 Fig. 4. Part of humerus of *Echidna hystrix*, corresponding to fig. 1
 Fig. 5. Ditto, back view, corresponding to fig. 1.
 Fig. 6. Humerus of *Echidna hystrix*.

than the corresponding bone in any living Monotreme), whereof I beg to enclose drawings; the bone is seen from three different points of view,—to which are added sketches of the same part of an *Echidna hystric* slightly enlarged. They may be figured, however, of the same size as the sketch, because I have before me the articulated skeleton of an *Echidna* in which the humerus is fully as large. The fragment in the possession of the trustees of this Institution is a portion of the distal part of this bone; the articulating surface, which fits into the sigmoid cavity of the ulna, is perfect; and, from its peculiar structure, it cannot well be mistaken for that of any other known mammal.

I have not yet seen any of the papers lately published by Professor Owen on Australian fossil remains; and as it is possible that a fossil *Echidna* is already described, I do not wish to name the present species; otherwise I should propose the specific term of *E. Owenii* for it.

I have the honour to be,
Gentlemen,

Your very obedient Servant,

Australian Museum, Sydney.

GERARD KREFFT.

November 23, 1867.

XX.—On the "Vitreous" Sponges. By Professor WYVILLE THOMSON, LL.D., F.R.S.E., F.G.S., M.R.I.A.

[Plate IV.]

THE classification of the PORIFERA is as yet extremely unsatisfactory. This arises chiefly from the circumstance that the essential part of a Sponge, the sarcode sheet investing the supporting framework, presents no visible distinctive characters, being apparently nearly the same in physical properties and in chemical composition throughout the whole series. Characters must therefore be founded upon accessory and comparatively unimportant parts; and these exhibit, with few exceptions, so finely graduated a series of minute variations that it is difficult to employ them in the definition of orders and suborders. Except in a few cases, but little stress can be placed upon the external form of the sponge-mass, even as a specific character. Often the general appearance of a sponge is characteristic enough, and a practised eye can easily recognize it in almost all its stages of growth; but it is impossible to embody the impressions on which this recognition is based in a description, or even to convey them by the most accurate figures. Hence the extreme difficulty in naming a collection

of Sponges from monographs and memoirs in which external form is chiefly considered, such as the beautiful work of MM. Duchassaing and Michelotti, and Johnston's 'British Sponges.'

The microscopic characters of Sponges, derived from the structure and form of the reticulated supports, and from the special forms of the spicules, are usually well marked; but these characters are in most cases of specific, in a few of generic, and in scarcely any of ordinal value. Fortunately, the chemical composition of the organs of support and of defence, two or three well-defined general types of structure and form of the spicules, and the general arrangement and mode of combination of the different parts, present some good points of distinction for larger groups.

I think that certainly the most satisfactory arrangement of Sponges is that proposed by Dr. Oscar Schmidt*. Dr. Schmidt's memoir, however, labours under the disadvantage of dealing with the Sponges of the Adriatic only; so that many remarkable exotic forms, which might have modified to some extent his ideas of classification, are excluded. In the second Supplement, indeed, the author institutes a comparison between the Adriatic Sponges and those described by Dr. Bowerbank; but the series is still incomplete, from the absence of illustration from the rich faunæ of the East and West Indies.

Dr. Schmidt divides the Adriatic Sponges into six groups, of the rank of families†. The first of these are the *Calcispongiæ*, which he thus defines:—"Spongiæ parvæ, plerumque albicantes, corpore spiculis calcareis pertexto."

It seems to be generally admitted that the Sponges with calcareous spicules are essentially distinct; and I am inclined to agree with Dr. Gray‡, who places them in a distinct subclass, antithetic to the whole of the remainder of the Sponges, which form in his arrangement a second subclass under the name of PORIPHORA SILICEA.

There is an evident awkwardness in placing such genera as *Spongia* and *Halisarca* (in which there is no silica whatever in any separate form) among the siliceous Sponges; still I think the classification is justifiable; and it is at all events convenient. The true horn Sponges pass by almost imperceptible gradations into the groups which develop distinct siliceous elements, either within the fibres (e. g. *Chalina*) or

* 'Die Spongien des Adriatischen Meeres,' Leipsic, 1862 (and two Supplements).

† Handbuch der vergleichenden Anatomie. Jena, 1865.

‡ "Notes on the Arrangement of Sponges," Proc. Zool. Soc. Lond. May 9, 1867.

among their meshes (*Diplodemia* &c.); so that I believe we may regard the whole group as potentially siliceous.

Dr. Schmidt's second family are the **Ceraospongiæ** :—"Spongiæ quarum sceletum formatur fibris solidioribus, recenti statu plus minusve elasticis, quæ sæpius aliena corpuscula involvunt, sed nunquam spicula in ipsis nata continent."

His third family are the **Gummineæ** :—"Spongiæ *Corneo-spongiis* proximæ. Parenchyma spississimum et maxime compactum, adpectu Kautschuk, quod tamen fibrillis tenuissimis contextum est. Generum pars corpuscula silicea continent."

The fifth family in Dr. Schmidt's arrangement are the **Halichondriæ** :—"Spongiæ spiculis siliceis pertextæ, quæ ob telam laxiorem et minus spissam quamquam sæpius subcorneam neque *Gummineis* adnumerantur, neque *Corticatis* ob defectum strati corticalis."

The careful consideration of the diagnoses of these three groups is quite as suggestive as the examination of an extended series of the Sponges themselves, of a single graduated line of forms in which there are no breaks of sufficient importance to justify its subdivision into groups of higher value than families.

The horn Sponges and the Gummineæ are so nearly allied that they can be distinguished by comparative characters only. The fibres of the horn Sponges are thicker, and the meshes wider, the whole texture is more open than in the Gummineæ, in which the minute fibres are matted together in the consistent sarcode, and the Sponge, when dried, looks like a piece of leather. The general aspects of the two groups are very distinct; and even to the inexperienced eye the Gummineæ form a natural and easily recognizable series, whose characters it is, however, scarcely possible to reduce to an intelligible definition. From the absence of positive characters, it is evident that these two groups are liable at any point to pass into one another. Among the Gummineæ separate siliceous spicules appear in abundance, the fibrillation of the horny matter becomes obscure; and we thus pass almost imperceptibly into the fifth group, the Halichondriæ.

Professor Schmidt's fourth group are the **Corticatæ** :—"Spongiæ globosæ vel tuberosæ; spiculis siliceis pertextæ, peculiari strato corticali circumdatæ, quod et tela organica firmiori fibrillosa et plerumque corpusculorum siliceorum genere a parenchymate interiori differt."

In this group we have positive characters of some value in the very marked difference between the cortical layer and the central mass, in the regular arrangement of the various histological elements, and in the peculiar type of the defensive

spicules, where these occur. I am inclined to regard the corticate group, as limited by Prof. Schmidt, as of ordinal value.

Prof. Schmidt's last family are the *Halisarcinæ*:—"Spongiæ molles, non fibrosæ, corpuscula calcarea vel silicea non continentes"—equivalent to the *Halisarcina* of Lieberkühn, an obscure group with neither horny fibres nor siliceous spicules, and consisting of little more than an extended sheet of sarcode.

The definitions of the three orders in Dr. Bowerbank's 'British Spongiadæ' are sufficiently simple; but I cannot regard the "KERATOSA" as a group equivalent to the "CALCAREA" and the "SILICEA."

The diagnoses of the suborders are based upon some important modifications in the arrangement of the spicules and horny matter, which do not, however, seem to be sufficiently definite for the purposes of classification. The groups are, on the whole, natural.

Admitting the value of Dr. Gray's two primary subclasses, the details of his classification seem to me unsatisfactory. The author divides the Siliceous Sponges into two primary groups—(1) those with membranous or unarmed ovisacs, and (2) those whose ovisacs are strengthened with siliceous spicules. I doubt if we know enough of the nature of these peculiar bodies which we for the present call ovisacs, to found upon them broad distinctive characters. The present attempt to do so separates to the utmost the nearly allied corticate genera *Tethya* and *Geodia*, and places *Spongilla* and *Halichondria* (*Isodictyon*) (between which, except in the one point of the structure of the "ovisacs," it is difficult to define generic distinctions) in different principal sections. Under the first two subsections of the MALACOSPORÆ, *Dactylocalyx* and *Spongia* are associated, on account of the common character of possessing a network, while *Aphrocallistes* is divorced from its beautiful partner *Euplectella*. The third subsection, the ARENOSPONGIÆ, is an excellent group, apparently of ordinal value.

Subordinate to the subsections, Dr. Gray proposes seven orders and a host of genera, and very naturally anticipates the general denunciation of a system which complicates the nomenclature to bewilderment, and founds generic groups upon such "imperfect materials" as a "bihamate spicule figured in Bowerbank's 'British Sponges.'"

The only classification which has any material advantage over the older classifications of Nardo, De Blainville, Johnston, and Lieberkühn, seems to be that of Dr. Oscar Schmidt. Duchassaing and Michelotti, Bowerbank and Gray, have each made valuable individual suggestions; but Dr. Schmidt's grouping, taken as a whole, appears to be the most in accordance with our knowledge of the anatomy and physiology of the class.

I believe we are now in a position to define another order, equal in value to the CORTICATA and the HALICHONDRIDA; and for this new order I would propose the term (Porifera) VITREA.

The following is an outline of the slight modifications which I would suggest in Dr. Schmidt's arrangement:—

Class PORIFERA, Grant.

Subclass I. (Porifera) CALCAREA, Bowerbank. "Skeleton composed of calcareous spicules which are generally three-rayed stellate" (Gray), equivalent to Dr. Schmidt's first family. Ex. *Grantia*, *Sycon*.

Subclass II. (Porifera) SILICEA, Gray. "Sponges provided with a siliceous or horny skeleton, or with a horny skeleton strengthened with siliceous spicules."

Order 1. (P. Silicea) VITREA. Sarcoderm in small quantity, very soft; never containing formed horny matter, either fibrous, membranous, or granular. The skeleton consists entirely of siliceous spicules, either separate (in fascicles or scattered) or anastomosing and combined into a continuous siliceous network. The sarcoderm contains small spicules of a different character from the general spicules of the skeleton, and of complicated forms. The spicules, whether of the skeleton or of the sarcoderm, may all be referred to the hexradiate stellate type. Ex. *Hyalonema*, *Dactylocalyx*.

Order 2. (P. Silicea) HALICHONDRIDA. Tuberous, branching, cup-shaped, irregular, or incrusting; without any definite external cortical layer. The sarcoderm is abundant, consistent, and in all cases is supported by a greater or less amount of formed horny matter, which is fibrous, granular and diffused, or in the form of more or less distinct membranous expansions. The sponge usually contains an abundance of siliceous spicules variously arranged.

Suborder 1. (Halichondrida) HALICHONDRINA (Lieberkühn). Sarcoderm abundant, usually consistent. The horny matter granular or membranous, but never in the form of a network of solid horny fibres. Skeleton consisting mainly of siliceous spicules, which are usually essentially of the same form in all parts of the sponge. In one family, the Esperiadæ, the sarcoderm is soft, and the spicules are of two distinct types. Ex. *Halichondria*, *Spongilla*, *Esperia*.

Suborder 2. (Halichondrida) GUMMININA (= Gumminæ, Oscar Schmidt). Sponge-substance compact; skeleton of fine densely interwoven horny fibres. Siliceous spicules in some of the genera. Ex. *Gummina*, *Corticium*.

Suborder 3. (Halichondrida) SPONGINA (Lieberkühn). Skeleton an elastic wide-meshed network of anastomosing horny fibres, frequently containing foreign bodies, such as grains of sand and spicules of other sponges, and occasionally siliceous spicules developed within them, and never associated with free siliceous spicules in the sponge-mass. Ex. *Spongia*, *Chalina*, *Dysidea*, &c.

Order 3. (P. Silicea) CORTICATA (O. Schmidt). Globular, tuberous, or branched Sponges, supported by regular radiating sheaves of long siliceous spicules, and invested with a special dense cortical layer, often containing spicules of special and characteristic forms. Ex. *Tethya*, *Geodia*, *Placospongia*.

Order 4. (P. Silicea) ARENOSA (= Arenospongia, Gray). "Sponge consisting of a disk of agglutinated sand, with a series of diverging spicules on the circumference of the disk, and a pencil of similar spicules at the mouth of the oscules on the upper surface of the disk." (Gray, l. c.) Ex. *Xenospongia*.

Order 5. (P. Silicea) HALISARCINA (Lieberkühn). Sponge an extended sheet of sarcode, destitute of either siliceous or horny support. Ex. *Halisarca*.

My principal object in the present communication is to define the first of the siliceous orders, the glassy Sponges. I believe the following to be the scope of the group in known genera and species:—

Order I. (Porifera Silicea) VITREA.

Genus 1. HABRODICTYON*, n. g.

H. speciosum, Quoy & Gaimard (sp.).

H. corbicula, Valenciennes (sp.).

Genus 2. HYALONEMA, Gray (in part).

H. Sieboldi, Gray.

H. lusitanicum, Gray.

Genus 3. EUPLECTELLA, Owen.

E. aspergillum, Owen†.

Genus 4. APHROCALLISTES, Gray.

A. beatrix, Gray.

Genus 5. DACTYLOCALYX, Stutchbury.

D. pumicea, Stutchb.

D. subglobosa, Gray.

D. Prattii, Bowerbank.

D. callocyathes, Gray (sp.).

D. azorica, Gray (sp.).

D. ? torva, Duchass. & Michelotti (sp.).

Genus 6. FARREA, Bowerbank.

F. occa, Bowerbank.

* ἁβρός, delicate, and δίκτυον, a net.

† Through the kindness of Dr. Farre, I have had an opportunity of see-

—an assemblage of the most beautiful, the most singular, and the rarest of marine productions.

GENERAL CHARACTERS OF THE GROUP.

Condition of the Sarcode.

From its essential simplicity and the want of any true structure, the sarcode of the glassy Sponges cannot be expected to afford any very marked distinctions; still even this element seems to differ in certain characters from the condition in which we find it in the other orders of Sponges. It is small in quantity, very soft, probably semifluid, extending in a thin layer over the fascicles of siliceous needles and over the siliceous framework. It appears to contain no trace of the diffused granular horny matter with which the more consistent sarcode of the Halichondrida is so often loaded. When a vitreous Sponge is dried (and all the specimens which have yet reached Europe are in a dry state), the whiteness of the skeleton is barely masked by the pale yellow film which represents the contracted animal matter. Most of the specimens of *Euplectella* in the market have been bleached; but some of them, which may be recognized by their pale fawn-colour, are merely dried; and if a portion of one of these be steeped for a short time in a warm weak solution of caustic soda, the sarcode softens and expands, and may be examined under the microscope with tolerable success. It is generally almost transparent, with here and there scattered endoplasts and minute compound granular masses. Among the meshes of the sponge-network, and everywhere except where it is extended (as in *Hyalonema* and *Euplectella*) over the surface of enormously long separate needles, the sarcode contains abundance of extremely minute spicules, scattered through it singly or aggregated in groups. These spicules, as we shall see hereafter, are often complicated in form and ornament, and are highly characteristic of the order and of the several genera.

The Siliceous Skeleton.

In *Habrodictyon* and *Hyalonema* the skeleton is composed entirely of separate siliceous spicules of various forms, interwoven in fascicles and connected by the thin sarcode layer, or scattered irregularly among the fascicles of spicules. In *Euplectella*, *Aphrocallistes*, *Dactylocalyx*, and *Farrea*, certain

ing his lovely specimen, upon which Professor Owen founded the species *Euplectella cucumer*. I can have no doubt that this is merely an example of *E. aspergillum* of a rather unusual form, which has attained its full size, but in which the raised spiral crests are as yet imperfectly developed.

kinds of these spicules are more or less completely fused together, forming a continuous anastomosing network.

Two forms of free spicules are extremely abundant throughout the group. The first are simply fusiform, frequently slightly curved, and often enlarged and tuberculated or otherwise armed or ornamented at one or both ends. These spicules vary greatly in length—from .05 to .5 of an inch in the skeletons of *Habrodictyon* and of the sponge-mass of *Dictyonema*, where they are grouped in fascicles and make up the greater part of the flexible network, to 3 or 4 inches in the silky fringe at the base of *Euplectella*, and to the enormous length of from 18 to 20 inches in the wonderful vertical wisp which is popularly known as the "glass rope" of *Hyalonema*.

These spicules have all essentially the same structure; they consist of extremely thin concentric layers of silica separated by films of sarcode, and are traversed throughout their entire length by a delicate canal, occupied in the fresh state by a sarcode axis.

The second form is called by Dr. Bowerbank "cylindro-rectangulated hexradiate" (British Sponges, vol. i. figs. 185, 186). It consists of a central shaft with the ends often spined or tuberculated as in the fusiform spicules. Near the middle of the shaft four secondary branches, at right angles to one another, form a cross, the radii at right angles to the axis of the shaft. The central canal is very distinct in the main axis, and sends branches into the four diverging radii. Rarely only two secondary branches are produced, but this is evidently by suppression. These spicules are large, sometimes .05 inch in length. They are scattered irregularly among the fusiform spicules in *Habrodictyon*, *Euplectella*, and *Hyalonema*, and are sometimes aggregated in groups.

The fusiform and the hexradiate spicules are modifications of one type. About the middle of one of the fusiform spicules, whether it be taken from the coil of *Hyalonema*, from the fringe of *Euplectella*, or from the general skeleton of any vitreous Sponge, if we use sufficient care and a sufficient magnifying-power, we can always detect one or two fine cross canals cutting the axial canal at right angles. When the cross canals have an appreciable length, two or four slight bulgings on the outer surface of the needle indicate their position (Pl. IV. fig. 1 c). It is remarkable that this hexradiate type of spicule, which is so abundant in the vitreous Sponges, is unknown in any other order.

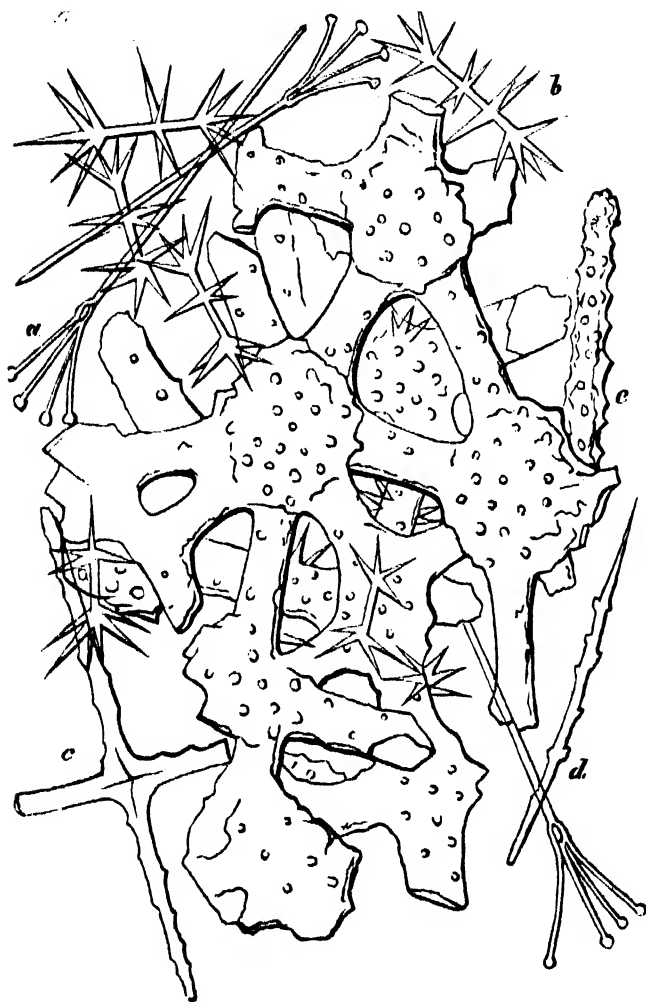
In *Hyalonema* the hexradiate spicules of the second form are usually if not always perfect and symmetrical. In *Habrodictyon* they are very frequently distorted, the rays twisted, and in

many cases several are partially united together. In *Euplectella* perfect and distorted spicules of this class are entangled in the loose meshes of a framework which is evidently formed by the still further distortion and anastomosis of spicules of the same type. In *Aphrocallistes* (see woodcut) the network is still more evidently produced by the coalescence of stellate spicules, though their hexradiate character is somewhat obscured. In the network of *Farrea* (Bowerbank, Brit. Spong. vol. i. fig. 277) the hexradiate type is very marked. The primary axis of the spicule is reduced to a conical tuberculated spine; and spines of exactly the same form are developed in a corresponding position on the outer surface of *Aphrocallistes* (woodcut, *e*). In *Farrea* the spicules are distinctly tubular; but this is merely a question of degree. In *Dactylocalyx* the reticulation has become very irregular; but I have no doubt, from the style of netting (see Bowerb. Brit. Spong. vol. i. fig. 275) and from the close analogy in other respects between this genus and *Aphrocallistes* and *Farrea*, that its fundamental plan is the same.

I believe that it would be safe to accept the generalization that the continuous siliceous network, wherever it occurs in the vitreous Sponges, is produced by the fusion of spicules of the hexradiate type.

Throughout the whole order the spicules of the sarcode are very abundant, and are often very elegant in form. They are extremely minute, usually not more than .001 of an inch in length or diameter, and are seen adhering in groups to the larger spicules, or entangled in multitudes among the fascicles and in the meshes of the sponge. However complex these spicules may finally become, they all, with perhaps one doubtful exception—the bihamate spicule figured by Bowerbank as from *Farrea occa* (Brit. Spong. vol. i. fig. 114)—may evidently be referred to the hexradiate type. In both species of *Habrodictyon* the most common sarcode-spicule is the "floricomo-hexradiate" of Bowerbank (Pl. IV. fig. 1 *e*); and the same form occurs abundantly in *Euplectella aspergillum*. The "coronato-hexradiate stellate" form figured by Bowerbank (Brit. Spong. vol. i. fig. 195) seems to be the central star of one of these without the curved processes. Associated with this type, we have in *Habrodictyon* multitudes of extremely minute hexradiate spicules, variously armed and feathered, and scarcely distinguishable from the ordinary spicules of the sarcode of *Hyalonema*. The spicule which in the series departs most from the hexradiate form is the wonderful double grapnel of *Hyalonema*; but, although its ends are split up into curving flukes, in the very middle of the shaft the cross-canals

betray the universal type. One set of the sarcode-spicules of *Aphrocallistes* is almost identical with the "furcated spiculated biternate" spicule figured from *Farrea occa* (British Sponges,



vol. i. fig. 199), but more spiny. I am afraid to name this form ; but I am sure it would be highly suggestive to Dr. Bowerbank.

Another set from *Aphrocallistes* are especially interesting (woodcut, a): they consist of a lengthened shaft ending in a small expansion, from which spring four equal branches, each terminated by a little knob. No doubt these are the separated branches of a complex hexradiate spicule closely resembling those figured by Bowerbank (British Sponges, vol. i. figs. 190–192) from species of the penultimate genus of our series, *Dactylocalyx*.

General Structure of the Sponges.

The netted walls of the two species of *Habrodictyon* are formed of a loose open network of fascicles of comparatively short fusiform spicules, the fascicles loosely bound together by the soft sarcode. The bundles curve irregularly in all directions, so that the network is quite irregular. No distinct bundles of long fibres pass longitudinally from end to end of the sponge, or transversely round it as in *Euplectella*. In *H. corbicula* the upper truncated end of the tube is closed by a netted lid, of a denser aggregation of spicules than that which forms the general wall; while in *H. speciosum* the general wall extends uniformly over the enlarged end of the tube without any change of structure.

The spongy portion at the base of *Hyalonema* resembles closely in minute structure the wall of *Habrodictyon*. The spicules are nearly of the same form, and are arranged much in the same way; but the bundles of needles are meshed into a porous conical mass whose parts tend to radiate towards, to be combined with, and to support a bundle of enormous spicules, whose lower portion is twisted into a close, compact, tapering coil in the centre of the sponge, while the upper part of the coil projects a foot above the centre of the sponge, and is frayed out in the water like a glittering brush of glass*.

In *Euplectella*, the long vertical spicules, instead of forming an isolated wisp as in *Hyalonema*, are separated into small fascicles, which are spread out symmetrically and connected into a netted tube by ring-like bundles of transverse fibres. The result is a wonderfully beautiful and symmetrical net with square meshes. Over this framework the general sponge-

* I have not space at present to discuss the curious diversity of opinion which exists as to the relations of *Hyalonema*. I will only refer the reader to an admirable memoir by Professor Max Schultze, 'Die Hyalonemen,' Bonn, 1860, to a second paper by the same author in the 'Annals and Magazine of Natural History,' March 1867, and to a paper of my own in the 'Intellectual Observer' of the same date.

substance, composed mainly of a siliceous tubing formed essentially by the coalescence of spicules of the hexradiate type in every condition of distortion, is regularly spread, partially closing and reducing to rounded pores, by an oblique tissue of interlacing threads, the square meshes of the frame, and rising on the surface of the sponge into irregular spiral ridges.

The mouth of the tube is closed, as in *Habrodictyon corbicula*, by a netted lid of dense tissue. Not taking into account differences in the form of the spicules, of specific value only—if the siliceous coil of *Hyalonema* were separated into small bundles and attached by transverse fibres within the wall of the tube of *Habrodictyon*, we should have a Sponge which would be referred without doubt to the genus *Euplectella*.

Aphrocallistes is very nearly allied to *Euplectella*. There are the same fascicles of longitudinal fibres within the tube, and there is the same netted lid; but the tube is irregular in form, and the siliceous network is much more dense and compact. It will be remembered that some of the spicules of the sarcode in *Aphrocallistes* resemble those in *Farrea*, while others correspond with the form hitherto only known in *Dactylocalyx**. In *Dactylocalyx* the longitudinal fascicles have disappeared, and the siliceous network is much more dense and irregular. A specimen from Barbadoes, which I saw in the Paris Exhibition, had almost the cylindrical form of *Aphrocallistes*; an example in the Belfast Museum is cup-shaped and looks like a silicified bath-sponge. I hope to have an opportunity of revising the whole of this genus or group of genera on some future occasion. The ultimate structure of its siliceous network and the close resemblance in form of its sarcode-spicules associate *Dactylocalyx* clearly with *Aphrocallistes* and *Farrea*.

Farrea is undoubtedly a vitreous Sponge allied to *Aphrocallistes*. The hexradiate type of the framework, and the spicules figured by Dr. Bowerbank (Brit. Spong. figs. 199, 200), are very characteristic. I am in doubt about the bilaminate spicule (*ibid.* fig. 114). From the condition of the only known example of *Farrea occa*, I should think it possible that one or many spicules of that form may have been mixed with it, possibly from some associated species of *Esperia*.

RELATIONS OF THE GROUP.

It is difficult even to speculate upon the position of the vitreous Sponges in the series of the Porifera. There is

* I am indebted to my friend Dr. Gray for an opportunity of examining the minute structure of *Aphrocallistes*. The woodcut represents a fragment of the general network of the wall of the tube, with some of the characteristic spicules of the sarcode alluded to above.

something in the wonderful complexity of design and profusion of ornament in the siliceous skeleton which reminds one strongly of the POLYCYSTINA; and even, in some cases, the special forms of the spicules are repeated in the two groups. (Compare pl. 12. fig. 1, pl. 17. fig. 4, pl. 18. fig. 15, pl. 21. fig. 7, pl. 32. figs. 10, 11, pl. 33. figs. 6, 7, &c. of Haeckel's 'Die Radiolarien'). As yet, we know nothing of any of the species in a living state. The sarcode is certainly somewhat different in character from that of the other groups of Sponges, —softer and more mobile, less loaded with granular formed matter, and more transparent. For sarcode in this condition we should be inclined to anticipate a somewhat higher form of vital activity. It remains to be seen whether there may be any approach by the extension of any form of pseudopodial processes to the condition of the sarcode in the RHIZOPODA. Under a strong impression that it is through this order that the Sponges pass into the RADIOLARIA, I have placed the PORIFERA VITREA at the head of the series of siliceous Sponges, beginning with those genera in which the siliceous elements are most independent and varied, and the sarcode least consistent. I believe that Dr. Gray has rightly indicated the base of the order by placing the Flower-baskets next the Esperiadæ, which I should certainly regard as the inosculating family of the HALICHONDRIIDA.

(Porifera Silicea). Order I. VITREA.

HABRODICTYON, n. g.

1. *Alcyoncellum*, De Blainville, Quoy & Gaimard, 'Voyage de l'Astrolabe,' Zoologie, vol. iv. p. 802. Paris, 1833.
2. *Alcyoncellum*, Deshayes and Milne-Edwards, in Lamarck's 'Animaux sans Vertèbres,' vol. ii. p. 580 (1836).
3. *Alcyonellum*, Owen (misprint for *Alcyoncellum*), Trans. Zool. Soc. vol. iii. p. 265 (1849).
4. *Alcyoncellum*, Bowerbank, Phil. Trans. and British Spongiadæ, vol. i. p. 174 (1865).
5. *Euplectella*, Gray, Ann. & Mag. Nat. Hist. vol. xviii. p. 487 (1866).
6. *Corbitella*, Gray, Proc. Zool. Soc. for 1867, p. 530.
7. *Heterotella*, Gray, Proc. Zool. Soc. for 1867, p. 531.

Sponge-body subcylindrical, tubular, attached by a slightly contracted base. The walls of the tube composed of a perfectly irregular network of bundles of siliceous needles loosely and irregularly arranged in sheaves crossing one another at low angles, and connected by a small quantity of soft mucilaginous sarcode. The spicules of the skeleton all essentially of the hexradiate form, free and separate from one another, or rarely connected in groups of two or three. The spicules of the sarcode very numerous, "floricomo-

hexradiate stellate," and various simple and branched modifications of the hexradiate type.

There seems to be something unusually fatal in the fascinations of these beauties. As to *Habrodictyon speciosum*, it certainly seems almost "useless to continue to quote the singular number of errors into which" every one appears to have "fallen in the description of this beautiful Sponge." Professor Owen, of whom this was first said, has certainly gone least astray, as he has succeeded thoroughly in the object which he had in view at the time, by giving us a description of *Euplectella aspergillum* which, if we combine with it that of *E. cucumer*, can scarcely be surpassed.

1. The use of the name *Alcyoncellum* by Messrs. Quoy and Gaimard, and the quotation of De Blainville's diagnosis of the genus, is clearly a *mistake*, arising from some confusion of the papers on the part of the compilers of this work. "Genre *Alcyoncelle* (*Alcyoncellum*). Corps phytoïde, subpierreux, solidifié par des spicules tricuspides; à branches peu nombreuses, cylindriques; fistulaire, terminé par un orifice arrondi, à parois épaisses composées de granules réguliers, polygones, alvéoliformes, percées d'un pore à l'extérieur et à l'intérieur. *Alcyoncellum speciosum*, nob., pl. 26. fig. 3. *Alcyoncellum cylindricum*, cavum, extremitate rotundum, album, reticulis lapidicis elegantissime contextum." The specific description does not in any way correspond with the diagnosis of the genus.

2. M. Milne-Edwards ignores altogether De Blainville's description, and refers the generic name *Alcyoncellum* to Quoy and Gaimard. He adds a fair description of the genus:—"MM. Quoy et Gaimard ont donné le nom *Alcyoncelle* à un corps qui paraît appartenir à la famille des Spongiaires, et qui présente une structure très-remarquable; on peut assigner au genre dont ce zoophyte est le type les caractères suivants:—Genre *Alcyoncelle* (*Alcyoncellum*). Spongiaire lamelleux dont la charpente est formée de filets très-déliés, accolés les uns aux autres, et entrecroisés de manière à former des mailles nombreuses, arrondies, assez régulières et semblables à celles d'une dentelle. On ne connaît qu'une espèce d'*Alcyoncelle*, qui est très-remarquable par sa beauté et qui a été rapportée des Molluques par MM. Quoy et Gaimard, elle a la forme d'un panier profond et étroit dont les parois seraient composées d'un tissu délicat d'un travail analogue à celui des sièges à rotang dont les modèles nous viennent de l'Inde. Ces naturalistes lui ont donné le nom de *Alcyoncelle specieux* (Quoy et Gaimard, Voyage de l'Astrolabe)."

3. Professor Owen recognizes, apparently from the figure in the 'Voyage de l'Astrolabe,' the generic distinctness of *Habrodictyon* from *Euplectella*. He gets into confusion, however, about the synonymy. "If the basal aperture of the cone were open, the resemblance to some of the known reticulate Alcyonoid Sponges would be very close, especially to that called *Alcyonellum gelatinosum* by M. de Blainville (*Alcyonellum speciosum*, Quoy & Gaimard); its closure by the reticulate, convex frilled cap in the present instance establishes the generic distinction."

4. Dr. Bowerbank's references and remarks are curiously inaccurate: Dr. Gray has, however, already done them full justice at the close of a short paper in the 'Annals' for 1866, except in one point. Dr. Bowerbank's definition of the genus *Alcyoncellum* is utterly inapplicable to the Sponge which he adopts as a type! and, in the simple process of adopting it as such, he contrives either to misname the Sponge or to misquote the authority.

5. Dr. Gray does not succeed in throwing much light upon the question; for, still under the fatal spell, he notices *Euplectella aspergillum* under the name of *E. speciosa*, and says:—"This Sponge was first described and figured, in 1833, by MM. Quoy and Gaimard, in the 'Voyage of the Astrolabe,' p. 302, Zoophytes, t. 26. f. 3, under the name of *Alcyoncellum speciosum*, from a very imperfect specimen which had lost the netted lid, the fringes on the outside, and a considerable portion of the smaller, lower end of the tubes." *** "There can be no doubt of the imperfect state of this Sponge, from a comparison with a worn and crushed specimen in the British Museum, that was obtained by Capt. Sir Edward Belcher, and purchased at the sale of his shells."

6 & 7. Dr. Gray has at length fully recognized *Euplectella* and the species in the French Museum as belonging to distinct genera; nay, he has founded *two* new genera upon the specimens in the Jardin des Plantes. I certainly suggested to Dr. Gray, in May last, in a letter which he has quoted (*op. cit.*), to define a new genus for the French forms; but I cannot possibly consent to the splitting of that genus. Genera are doubtless of the highest convenience if they represent *groups* of nearly allied species; but to give a generic name to almost every species, entirely does away with the value of the genera, and, instead of assisting the student, only adds to his perplexity. For a time I doubted whether these two forms were distinct species; and I was inclined to regard the specimen of *A. speciosum* as a variety grown under peculiar circumstances, and the short *A. corbicula* with the netted lid as

the normal form. I am not quite satisfied on this point even now. As I am precluded from using either of Dr. Gray's names, I substitute one which I had in MS. before I saw Dr. Gray's paper.

H. corbicula, Valenciennes (sp.). Pl. IV. fig. 1.

Alcyoncellum corbicula, Val. (in Paris Museum); Bowerbank, British Spongiadæ, vol. i. p. 176.

Heterotella corbicula, Gray, Proc. Zool. Soc. 1867, p. 531.

The Sponge is tubular, shaped somewhat like a wine-glass, about 4 inches high and 2 inches wide across the lip, and tapers downwards somewhat irregularly to a diameter of $1\frac{1}{2}$ inch at the base. The wall of the cylinder is formed of a rather thick irregular network of delicate siliceous spicules, from $\cdot 01$ to $\cdot 5$ inch in length, loosely arranged in fascicles which cross one another at low angles, and are loosely connected and combined by a small quantity of very soft mucilaginous sarcode, which, in the dried sponge, remains as a thin yellowish film. These cords curve upwards and downwards and round, anastomosing in all directions, and leaving between them rounded openings of various sizes, and show no tendency whatever to a regular longitudinal and transverse direction. All the long spicules are formed on the hexradiate type; but the four secondary rays are usually abortive, being represented merely by four tubercles at right angles to one another, about the middle of the main shaft, which is somewhat enlarged and tuberculated at each end (Pl. IV. fig. 1 c). The spicules have, according to the ordinary plan of sponge-structure, a delicate centre canal, which sends off four short radii to the four secondary tubercles. The walls of the spicules consist of concentric layers of silica separated by films of sarcode, which can be readily shown discoloured by burning in a spirit-lamp. This structure can be best studied in the long spicules of *Hyalonema*, which are in every respect, except in size, essentially the same.

Scattered among the long spicules of the skeleton, there are many fully developed hexradiate spicules. Some of these are perfectly regular in form, the rays smooth and nearly equal (Pl. IV. fig. 1 b); but many of them are irregular, the rays are distorted and bent (fig. 1 a), and in some cases two or more are irregularly united together. I have little doubt that these latter indicate the first stage, as it were, to the formation of a continuous network such as we find in *Euplectella* and *Aphrocallistes*. In *Habrodictyon*, however, the coalescence never occurs to any extent, and the network remains perfectly flexible and without a trace of the raised filigree ridges which

are so characteristic of *Euplectella*. The long hexradiate clubbed spicules and the irregular hexradiate spicules make up the mass of the skeleton.

The investing film of sarcode is thickly studded with extremely minute spicules, which in the dried sponge seem to be adhering to the larger spicules and irregularly massed among them. On shaking the sponge, quantities of these minute spicules of the sarcode fall out. They are of two marked types. The most abundant are small hexradiate stellate spicules (Pl. IV. fig. 1*b*, $\times 250$), with the rays nearly equal, formed exactly upon the same plan as the larger spicules of the skeleton, with a well-marked but extremely minute six-rayed tube occupying the centre of the rays. The rays when broken show the same lamellar structure as the larger spicules. The second type is also very abundant; but it is rare to find these spicules at all perfect: it is the "floricomo-hexradiate stellate" of Bowerbank. The centre of the spicule is hexradiate stellate, like the other spicules; but each ray, not more than four times its own width from the point of divergence, spreads out into several, probably six or eight, expanded plates: these plates curve outwards and form a cup; they then bend upwards and slightly inwards, and become so extremely delicate that they are little more than visible under a high magnifying-power; finally they sweep upwards and outwards, ending in a trifid expansion. These trifid ends turn gracefully over, so that the processes from each of the six radii unite in producing a beautiful vase-like form. A perfect spicule with all its vases complete is an exquisite microscopic object. The star-like centres of these spicules are not very common; but the sarcode is full of the ultimate branches. (Pl. IV. fig. 1*f*.) The vast number of these separate hooks may be explained by the extreme tenuity of their attachments to the central stars. The strain of the contraction of the sarcode in drying may probably be sufficient to break them off. These spicules appear to be most abundant near the edges of the openings in the network.

The conical sponge is abruptly truncated above, the wall ending in a well-defined ridge or lip, somewhat more dense in structure than the rest of the wall. The tube is then closed by a very irregular, horizontal, netted lid, composed of fibres which are much more thread-like and closer in their texture than those of the wall. The ultimate elements of the fibres of the lid, however, are exactly the same as those of the wall-network; only the large stellate spicules are less numerous, and the fusiform spicules are usually much shorter. The spicules of the sarcode are equally numerous and of the same character throughout.

The only known specimens of *Habrodictyon corbicula* are in the Museum of the Jardin des Plantes. They are three in number: one is perfect, another is torn through the middle, and the third is a mere fragment. Through the friendly courtesy of M. Lacaze-Duthiers, I had an opportunity of examining them carefully; and, by his permission, an admirable photograph of the perfect specimen was taken for me by M. Potteau. This photograph is copied, reduced one-third in size, in Pl. IV. fig. 1. The specimen is labelled "*Alcyoncellum corbicula*, Val. Donn   par M. Saches. 1857."

H. speciosum, Quoy & Gaimard (sp.). Pl. IV. fig. 2.

Alcyoncellum speciosum, Quoy & Gaimard, 'Voyage de l'Astrolabe', Zoologie, vol. iv. p. 302.

Alcyoncellum speciosum, Milne-Edwards, in Lamarck's 'Animaux sans Vert  bres', vol. ii. p. 589.

Alcyonellum gelatinosum and *A. speciosum*, Owen, Trans. Zool. Soc. vol. ii. p. 205.

Alcyoncellum corbicula, Bowerbank, British Spongiadae, vol. i. p. 174.

Euplectella speciosa, Gray, Ann. & Mag. Nat. Hist. ser. 3. vol. xviii. p. 467.

Corbitella speciosa, Gray, Proc. Zool. Soc. for 1867, p. 530.

The Sponge is tubular, about $7\frac{1}{2}$ inches in height, expanding gradually upwards from a contracted base $1\frac{1}{4}$ inch in diameter to a width of about $2\frac{1}{2}$ inches at the upper extremity. The network forming the wall of the tube is the same in general structure and arrangement as in *H. corbicula*, but the fibres are finer and more defined and compact in texture. The wall of the tube rises to no definite lip, and forms no terminal lid, but the ordinary network of the wall simply arches over and closes the wide end of the tube without any change of structure. As a rule, the spicules of the skeleton are identical in form and arrangement with those of *H. corbicula*; the fusiform spicules seem to be somewhat longer, and the irregular hexradiate spicules less abundant. All the sarcode-spicules of *H. corbicula* are repeated in *H. speciosum* in nearly the same numerical proportions; but in the latter species a minute spicule (Pl. IV. fig. 2 a, $\times 1000$) occurs in great abundance, while it is rare, if it occur at all, in *H. corbicula*. This is probably Bowerbank's "bifurcate rectangulated hexradiate spicule" (British Sponges, fig. 188); it recalls in general character and physiognomy a small spicule very abundant in the sarcode or *Hyalonema*, figured in the 'Intellectual Observer' of March last, plate 1. fig. 10. The abundance of this special spicule in *H. speciosum* has chiefly weighed with me in regarding the two forms of *Habrodictyon* as distinct species; it would be necessary, however, to examine a larger series to arrive at a definite conclusion on this point.

Dr. Bowerbank supposes that in this group the openings of the lid and those of the tube will stand to one another in the relation of oscula and pores: "The whole of the parietes are appropriated to inhalation." The distal end of the cloaca "is partially closed by a cribriform veil, the orifices of which appear to be the true oscula of the sponge." (Bowerbank, *British Sponges*, vol. i. pp. 176, 177.)

This is a gratuitous assumption, and seems improbable. Even in *Euplectella*, in which the formation of the lid is most perfect, the meshes of the tube-wall are individually as large as the openings in the lid, and collectively represent an area of a hundred times their extent. It seems to me that in a fixed organism of the form of *Euplectella*, with so open a structure, the resistance at the contracted "oscular area" would be sufficient to overcome any ciliary current concentrated upon it, and to send the water back through the open network. It is surely much more likely that each of the large openings in the wall is occupied by an exhalant orifice, and that inhalation takes place as usual by minute pores in the interstices between the spicules of the skeleton. Indeed this is scarcely an open question; for in the unique specimen of *H. speciosum* there is no lid, and the apertures are of the same character throughout.

The only known specimen of *H. speciosum* is that figured by MM. Quoy and Gaimard in the 'Voyage de l'Astrolabe,' and now in the Museum of the Jardin des Plantes. It is represented (Pl. IV. fig. 2) reduced one-third, from a photograph, of the natural size, by M. Pottean.

The specimen is labelled "*Alcyoncellum corbicula*, Val. Tiré par 80 brasses de profondeur dans la rade de St. Denis de Bourbon par M. Leschenault, 1819."

EXPLANATION OF PLATE IV.

Fig. 1. *Habrodictyon corbicula*, reduced one-third.

1 a. One of the distorted hexradiate spicules, $\times 100$.

1 b. A regular hexradiate spicule, $\times 250$.

1 c. One of the ordinary filiform spicules of the skeleton, showing the tubercles which represent the secondary rays, $\times 160$.

1 d. The enlarged end of such a spicule.

1 e. A portion of one of the "floricomo-hexradiate stellate" spicules, $\times 800$.

1 f. One of the separated branches, front and lateral views, $\times 1000$.

Fig. 2. *Habrodictyon speciosum*, reduced one-third.

2 a. One of the spicules of the sarcode peculiar to this species, $\times 1000$.

XXI.—*Notulæ Lichenologicæ*. No. XX.

By the Rev. W. A. LEIGHTON, B.A., F.L.S.

EVERY lichenist is unfortunately well aware of the great difficulty of preserving specimens of lichens which grow on the earth. Too frequently he finds, on consulting his herbarium, that the earth on which such lichens grew has become dry and crumbled into dust, involving in such disintegration the destruction of the lichen itself, especially when this happens to possess a crustaceous thallus. To remedy this a solution of gum arabic has been sometimes used, but with partially satisfactory results only, inasmuch as the mucilage does not penetrate the earth, but only conglomerates its surface. An effective preparation appears to have been discovered by M. J. M. Norman, of Trömsø, Norway. It consists of a solution of isinglass in spirits of wine, such as is used in the preparation of English adhesive plaster, which a chemist informs me is better known as "Prout's plaster." This composition, when liquified in a vessel plunged into water of the temperature of 25°–30° C., is greedily imbibed by the earth on which the lichen grows, and becomes inspissated into a solid gelatine at a temperature below 15°. The solution may be applied by a camel's-hair pencil until the earth becomes saturated; but care should be taken that the lichen itself be not moistened with it, for otherwise it would become discoloured. When the surface has become dry, the specimen may be submitted to moderate pressure, which, after some days, produces the requisite hardness and tenacity. The favourable experience of some years encourages M. Norman to recommend this preparation to his fellow lichenists.

XXII.—*On the Spongiæ ciliatæ as Infusoria flagellata; or Observations on the Structure, Animality, and Relationship of Leucosolenia botryoides, Bowerbank**. By H. JAMES-CLARK, A.B., B.S., Professor of Natural History in the Agricultural College of Pennsylvania†.

[Plates V., VI., VII.]

I HAVE been engaged like others, for some time past, in endeavouring to clear up the doubt which prevails in the scien-

* A sketch of the contents of this memoir has already been published in the 'Proceedings of the Boston Society' for June 20, 1866; the 'American Journal of Science' for November 1866, and in the 'Annals' for January 1867.

† From a separate impression from the 'Memoirs read before the Boston Society of Natural History,' vol. i. part 3; communicated by the author.

tific community in regard to the nature of the Sponge. The question has been, is it an animal or is it a plant? Bowerbank, the highest classificatory authority upon this subject, for a long term of years held that it was an animal; but his *bases* for this theory were such that they did not appear to offer a satisfactory means of finally deciding the dispute. The latter remark applies with equal force to the investigations of Lieberkühn. Of later years Carter has made some special investigations in reference to this subject, and in fact he has been the first to present anything like decisive proofs of the animality of the Sponge. A few words quoted from his paper, which he published in the 'Annals and Magazine of Natural History' for April 1857, vol. xx. p. 30, will suffice to show to what extent he has carried his observations. Speaking of the "monociliated sponge-cells of the ampullaceous sac," which, he says, was set free by the disintegration of the whole mass of the sponge, he remarks that "particles . . . were thrown [by the flagellum] almost point-blank on its surface, and rapidly passed into the interior." Strangely enough, though, as it seems to me now, he does not look upon the intussusception of the particles as a genuine process of swallowing, like that which obtains among the ciliated Infusoria, but describes it in several places, when speaking of the various kinds of sponge-cells, as an enveloping of the food after the manner of *Amœba*. It is plain, therefore, that he does not believe that the "sponge-cells" are endowed with a *mouth*; and moreover, if I am not mistaken, he attributes to any part of the "cell" the faculty of engulfing food. This interpretation, therefore, would exclude the Sponge from the list of Flagellata, notwithstanding the presence of the *flagellum*. That, however, does not weaken the proof as to the animality of this organism, but merely leaves it (as Mr. Carter believes it to be) in the most intimate alliance with the naked Rhizopoda; and, as if to confirm this conclusion, the same authority adds, "These monociliated sponge-cells present the contracting vesicle* in great activity, but also in variable plurality." I believe, however, that the "variable plurality" of the contracting vesicles does not alone belong to the Rhizopoda, but, as I shall show hereafter†, that it is also to be observed among the true Flagellata; and I would remark, moreover, that when we consider the close relationship (which I hope to prove in this paper) of the Sponge to the other flagellate monad-like Infusoria, which undoubtedly

* Already noticed by him, in 1847, in the Trans. Bombay Med. and Phys. Soc. (abstract in Ann. & Mag. Nat. Hist. 1848).

† *Salpingoeca marinus*, n. sp., § 8, and *S. amphoridium*, n. sp., § 9.

have a definite oral aperture, we must, if on no other grounds, conclude that it also possesses a true mouth.

Still there would appear to be some who doubt whether, after all, the Sponges are really animals instead of plants, and moreover seem to insist that they are neither the one nor the other, but form with other Infusorians (such as *Volvox*, *Gonium*, *Pandorina*, *Euglena*, and other Conferva-like bodies) a group by themselves, standing intermediate to, and partaking of the nature of, both animals and plants. This is the group which has been called Phytozoa, *i. e.* plant-animals.

In the midst of this halting decision, I have been for some years past working upon a class of Infusoria the knowledge of whose structure fully prepared me not only to recognize the animal nature of the Sponge, but also enabled me to determine to what group of Infusoria it belongs. Such a decision, therefore, does not leave any trace of doubt in my mind as to the strictly animal nature of the Sponges. The whole question in dispute hinges upon the determination as to the animal or vegetable nature of the Monad-like or so-called Flagellate Infusoria. And here, again, I would say that it has fallen to my lot to decide, for the first time, that one of the smallest of the known Infusoria, the Monad (*Monas termo*, Ehr. ?) is an animal. If, now, we can prove this point, the way is perfectly clear through the intermediate forms which lie between the Monad and the Sponge.

Commencing, then, with what I believe to be the *Monas termo* of Ehrenberg, I shall proceed to describe in detail a series of forms (several of which are new, both generically and specifically) which stand in the closest relationship among the lowest embodiments of infusorial life, embracing among them, as I hope to show, the true ciliated Sponges, and which, notwithstanding, lead in unobstructed although varied courses * to the more elevated kinds of Protozoa, the true Infusoria ciliata.

§ 1. *Monas termo*, Ehr. Pl. V. figs. 1, 2, 3, 4.

Upon a slight acquaintance with this infusorian, one would be strongly inclined to identify it with the younger stages of *Anthophysa Mülleri*, Bory (fig. 49); but a more searching investigation reveals such a number of characters in each which are not to be found in the other, that one need not have any hesitation whatever in setting them down as totally diverse organisms. In fact *Monas* belongs to the unciliated Flagellata, whilst the other genus just mentioned is a biciliate heteronematous form.

Monas lives in two diverse conditions, of which one is a

* See the preliminary remarks upon *Anthophysa*, § 11.

fixed state (fig. 3), and the other a free and motile stage (figs. 1, 2, 4). During its sedentary life, it may be found in great abundance on the old stems of *Myriophyllum*, *Potamogeton*, *Ceratophyllum*, and other aquatic phænogamous plants which inhabit quiet waters, and are more or less thickly covered by a floccose overgrowth of various minute *Confervæ*, *Diatomaceæ*, &c. In its free state it swims with either a sort of hitching, wriggling motion, or, gliding along smoothly, revolves at an inconstant but never rapid rate upon its longer axis, of which the flagellum (fig. 2 *f*), which always precedes it, may be said to be a prolongation. This is the condition in which it is most frequently to be found after it has been kept a few days in an aquarium. It then gathers in swarms about decomposing matter, and thus affords frequent opportunity of seeing its mode of collecting and swallowing its food.

The *form* of the body in a fixed state (fig. 3) may be compared to a flattened heart, of which one summit is prolonged into a broad, conical, transparent beak (*lp*), and at the opposite end the apex is attached to a slender, flexible pedicel (*pd*), which frequently is equal in length to four or five times the antero-posterior diameter of the body. In a free condition (fig. 2) the posterior end is rounded and about as broad as the front, but still it presents the same lateral flattening as the fixed form. The prevailing colour is a faint olive or yellowish green.

The *flagellum* (*f*) is the only cilium-like organ which this creature possesses. It is attached to the front, close to the proximal side of the conical beak (*lp*), and consequently lies in the axial line of the body. In a quiet state, which it most frequently assumes during the fixed condition, it appears like an arcuate bristle, and extends from near its base to its apex in one uniform, slightly but distinctly curved line, and terminates without any very sensible diminution in thickness. The plane of its curve is in direct extension of the plane of the greater diameter of the body, and at the same time passes through the conical beak. During natation the flagellum takes precedence and vibrates with an undulating whirling motion which is most especially observable at its tip, and produces by this mode of propulsion the peculiar rolling of the body which at times lends so much grace to its movements as it glides from place to place. During the fixed state of the body the chief design of the movements of the flagellum is the prehension of food; and this is accomplished by a peculiar abrupt deflection of the end of this organ towards the *front*, by means of which particles of various kinds are made to impinge upon the region immediately at the proximal side of the

base of the broad conical beak—a point at which, as will be seen presently, the mouth is situated.

The *mouth* (figs. 3, 4, *m*) lies between the base of the flagellum (*f*) and the beak, or *lip* (*lp*), as I shall hereafter designate it, from its obvious office, presently to be described. A plane, therefore, drawn through the lip and the base of the flagellum, would also strike the mouth, and moreover form a continuation of that of the greater diameter of the body. This aperture is not visible during its closed state; but its presence has been often and unmistakeably determined by seeing the masses of food enter invariably at the point designated above. As already stated, particles are thrown with a sudden jerk, precisely as is done by *Anthophysa Mülleri*, Bory (figs. 50, 51), and apparently with great precision, directly against the mouth (fig. 4, *m*). If acceptable for food, the flagellum presses its base down upon the morsel, and at the same time the lip is thrown back (fig. 4, *lp*) so as to disclose the mouth, and then bent over the particle as it sinks into the latter. When the lip has obtained a fair hold upon the food, the flagellum withdraws from its incumbent position and returns to its former rigid, watchful condition (fig. 4, *f*). The process of deglutition is then carried on by the help of the lip alone, which expands laterally until it completely overlies the particle. All this is done quite rapidly, in a few seconds; and then the food glides quickly into the depths of the body, and is enveloped in a digestive vacuole (*d*), whilst the lip assumes its usual conical shape and proportions.

The *contractile vesicle* (figs. 2, 3, 4, *cv*) is a much larger and far more active organ than that of *Anthophysa* (figs. 47, 48, *cv*). If we view the body from its narrower aspect (fig. 2), when it stands so that the lip (*lp*) is nearest the eye, the contractile vesicle (*cv*) appears in profile, on the left broad side, and so close to the surface that it seems to project beyond the general outline of the body. It lies in the anterior third of the broad side just mentioned, and close to the transverse plane which separates that part which contains it from the one upon which the lip is placed. From whichever direction, therefore, one views this organ, it will be seen to stand in an asymmetrical relation to the rest; and as it is preeminently a dominant feature, it may serve, perhaps better than any other, as a starting-point in determining the obliquity of the type of this infusorian, and its perfect consonance in this respect with that of the more obviously spiral forms, such, for instance, as are exemplified by *Dysteria* (figs. 77, 78) and *Pleuronema* (figs. 75, 76). It is so large and conspicuous that its globular form may be readily seen, even through the greatest diameter of the body; and it

contracts so vigorously and abruptly, at the rate of *six times a minute*, that there seems to be a quite sensible shock over that side of the body in which it is imbedded.

The *reproductive organ* may possibly be represented by the very conspicuous, bright, highly refracting, colourless, oil-like globule (*n*), which is enclosed in a clear vesicle, and appears to be so constantly present in the depths of the posterior third of the body. Its position seems to be invariably on that side of the transverse axial plane which is opposite to that in which the contractile vesicle (*cv*) lies. Nothing further of a positive nature can be said in regard to this body; but we may conjecture that, inasmuch as it cannot well be assigned to any other office, not even to that of an eye-spot, it is in all probability an organ of reproduction.

In regard to the *stem* (fig. 3, *pd*), it may be added that, although it appears to be of the simplest nature—a mere gossamer thread as it were, it is none the less positive, as a support, than that of *Anthophysa* (figs. 47, 48, 49, *pd*), and must indeed possess a similar self-reliant power in order to keep the body in the same relative position in regard to the object to which it is attached, or to sustain it in an upright attitude at a time when the flagellum is quiet and there is consequently no other means of preventing the animal from sinking down upon the nearest fixed point.

§ 2. *Monas neglecta*, nov. sp. Pl. V. figs. 5, 5^a, 5^b, 6.

To a casual observer this species would appear to be one of the varieties of *Monas termo* of § 1; and I must confess that, under an amplification of only five hundred diameters, the mistake would be easily made, unless one had become perfectly familiar with the two by prolonged study with a much higher magnifying-power. There is, though, a physiological difference which can be observed when all others could scarcely be noted, which is this: the rate of the systole of the contractile vesicle (*cv*) of this species is double that of *Monas termo*. Like the latter it enjoys two diverse conditions of life—namely, a fixed (figs. 5, 5^a, 6) and a free (fig. 5^b) state,—frequents the same habitat, progresses with the same means and mode of locomotion, and obtains its food by similar prehensile organs, and swallows it in the same manner.

The *form* of the body is that of an oval, but terminates anteriorly in an obliquely truncate front; or, rather, one side of the front projects in the form of a low, rounded prominence, which constitutes the *lip* (*lp*). The posterior end is either broadly rounded or very bluntly pointed where the pedicel (*pd*) is attached. The colour is either greyish or there is none at all.

The *flagellum* (*fl*) has more of a sigmoid flexure than that of *Monas termo* (figs. 1-4), and about as much as that of *Anthophysa Mülleri*, Bory (figs. 47, 48, *fl*). It arises from the axial point of the front, and extends to about three times the length of the body. The plane of its curve bears the same relation to the mouth and lip as that of *Monas termo*, and it is used in the same manner as a prehensile organ to assist the lip (fig. 6, *lp*) when taking food, and for a propelling-apparatus (fig. 5^b, *fl*), as the body whirls along after it during natation.

The *mouth* (fig. 6, *m*) lies in the same relative position as that of *Monas termo*, and receives its food in precisely the same manner, and, by the assistance of the lip (*lp*), with the same degree of rapidity passes it into the body.

The *contractile vesicle* (*cv*) lies on the same side of the plane of the arcuate flagellum (*fl*) as that of *Monas termo*, and at about the same distance from the front, but in an opposite region, and directly in the antero-posterior line with the lip. It is also a more vigorous and larger organ than that of the other *Monas*; and, bulging out (fig. 5^a, *cv*) the body even more strongly during expansion, its systole takes place at double the rate (that is, *twelve times a minute*), and very abruptly.

The *pedicel* (*pd*) sometimes attains to four or five times the length of the body, but most frequently it is not more than half as long as that. It is thin and delicate, but appears to possess considerable rigidity, either in a fully extended state, or when (as appears to be the case sometimes) it is contracted into more or less abrupt curves (fig. 6, *pd*). Its apex (fig. 5^a, *pd*¹) is attached to the posterior end of the body, at a point which is coincident with the longitudinal axis.

§ 3. BICOSÆCA, nov. gen.*

Bicosæca gracilipes, nov. sp. Pl. V. figs. 34, 35.

This genus might be compared to a *Monas* seated in a calyx, and upon a highly muscular, contractile stem.

Bicosæca gracilipes is a marine form, and has thus far been found, although in considerable numbers, only upon *Sertularia cupressina*, Linn. It is an excessively minute creature, as may be readily judged by the reader upon referring to the magnifying powers which are laid down in the description of the figures. When first met with, it appeared, upon a casual observation and under a magnifying-power of only five hundred diameters, to be an elongate, naked *Monas*, which was kept in a firm position by some invisible power. It soon, however, attracted particular attention to itself by its peculiar, spasmodic

* *βίκος*, a vase; *οικέω*, to inhabit.

and often-repeated retrocession. Upon putting on a power of eight hundred diameters, the whole organization was brought out with sufficient clearness to satisfy one upon every point. For the purposes of illustration, however, it was thought best to increase the magnifying-power to a still greater extent; and we have, therefore, drawn one figure (fig. 34) to represent this infusorian as it appears when seen under an amplification of about fifteen hundred diameters.

This animal has never been found in a free state, or in any other than that which is represented in these two figures (figs. 34, 35). It has an elongate oval body, which is enclosed in a deep vasiform, pedicellated calyx (*c*), to whose bottom it is attached by a slender, colourless, contractile ligament (*r*). It usually rests about halfway between the top and bottom of the calyx, but is frequently jerked to the bottom (fig. 35) of the vase (*c*) by means of the ligament just mentioned. The anterior end is truncate, and prolonged into two prehensile organs, one of which is a *flagellum* (*f*), and the other a *lip* (*lp*) similar in position and function to that of the *Monas* described in the previous section. The generally prevailing fuscous tint is interrupted by a transparent colourless streak (*r*¹), which extends from the laterally posited base of the flagellum (*f*) to the posterior end of the body, where it seems to be prolonged into the contractile ligament (*r*). It is not a band, however, but a sharply defined furrow, of considerable depth. At the anterior end it is sunk so deeply that it borders closely upon the base of the flagellum, and from that point it gradually shallows until it nearly disappears at the point of junction of the body with the contractile ligament.

We are thus reminded of those heteronematous Flagellata, like *Anisonema* (figs. 65-69), whose bodies are so conspicuously sulcated in a longitudinal direction; and the apparent continuity of the retractor ligament (fig. 34, *r*) with this furrow (*r*¹) heightens the impression, by its resemblance to the highly muscular trailing lash (figs. 65-69, *f*¹) of that genus. One could hardly be accused of unduly straining a point in homology if he were to regard the furrow (fig. 34, *r*¹) in question as merely a greatly prolonged ostial notch, and the retractor (*r*) as a trailing lash, which originated at the greatest possible distance from the other, its proboscidal companion (*f*).

The *lp* (*lp*) is a more prominent organ than that of *Monas*. It has a conical shape, and is about twice as long as its greatest breadth. It is so hyaline as to readily escape notice until it is fully recognized. It is situated at the edge of the truncate front opposite to that from which the flagellum arises, and therefore leaves a considerable space between the latter and

itself. Within this broad space the simple mouth (*m*) is situated.

The *flagellum* (*f*) is the most active of the prehensile organs, and the only vibratory filamentous body which this animalcule possesses. In length it is about three times that of the body, or a little more, and projects far beyond the rim of the vase (*c*). It is a curious fact that while in *Monas* and *Anthophysa* the lip and flagellum lie closely together, they stand far apart in *Bicosæca*. The flagellum is not an undulatory, vibrating organ, in the common sense of the term, but usually supports itself in a rigid condition, except at the tip, which is kept in nearly constant motion, incurving with frequent jerks, and tossing floating particles toward the mouth. Its distal two-thirds is quite strongly curved, but not so much as to be absolutely falcate; and at its basal third it is moderately arcuated in the opposite direction, so that the whole flagellum has a slightly sigmoid flexure. The plane of this curve is such as to strike the mouth and lip when carried out in that direction. The diameter of this organ is about equal from tip to base, excepting a slight thickening at the latter point. The only times that the flagellum abandons its rigid deportment are either when it is assisting the lip to seize the food, or during the spasmodic retrocession of the body. In the latter case it is abruptly retracted and coiled (fig. 35, *f*) transversely within the calyx (*c*) close down to the truncate front of the body. When the latter slowly pushes forward from the bottom of its dormitory, the flagellum as deliberately uncoils, and at first vibrates with a rapid wriggle, but finally assumes its former sigmoid curve and rigid deportment.

The *mouth* (*m*), as has already been mentioned incidentally, lies in the middle of the truncate front, and consequently faces toward the aperture of the calyx (*c*). Food is brought to it by means of the flagellum (*f*); and the latter and the lip (*lp*) force it into the oral aperture exactly in the same way as has been described in regard to *Monas*.

The *contractile vesicle* (*cv*) is a single globular organ, which lies on the corresponding side of the body with that of *Monas*, and just in front of the middle. In full diastole its diameter equals one-third of that of the body. Both the systole and diastole are very slow.

The *calyx* (*c*) is about twice as long as the body which it encloses, and between four and five times its own average diameter. It has the form of a very deep slender urn, with a rounded bottom, slightly contracted waist, and a very delicate, scarcely reverted, truncate rim. It is so hyaline and faint that it almost defies any magnifying-power below that of eight

hundred diameters. The pedicel (*pd*) which supports it is at least twice as long, of uniform diameter throughout, and very slender, in fact not much thicker than the flagellum. It is attached (*pd*¹) to the bottom of the calyx, exactly opposite to the point from which the contractile ligament (*r*) arises; but, unlike the latter, it appears to be totally incapable of contraction.

[To be continued.]

BIBLIOGRAPHICAL NOTICES.

The Natural History of the Tineina. By H. T. STANTON.
Vol. X. 8vo. London: Van Voorst. 1867.

BEFORE saying anything upon the contents of the present volume, we must congratulate Mr. Stainton upon having reached the first halting-place in his laborious undertaking. He has every reason to glance back with satisfaction over the ten beautiful volumes which he has produced in the last thirteen years; and although he himself speaks, in a somewhat deprecatory tone, of his having failed to keep up to his original estimate of two volumes annually, we fancy that most of his readers will think that he has accomplished a gigantic amount of work.

The present volume contains the Natural History of twenty-four species of the genus *Gelechia*; so that, with the contents of the ninth volume, Mr. Stainton has illustrated forty-eight species of that difficult group. But such is the progress of discovery now-a-days that it seems difficult for an author even to keep pace with it. These forty-eight species are scarcely more than a fifth of the known European members of the genus, which now, according to Mr. Stainton's list of them, amount to 231; but of these the transformations of only about 100 are known, so that in reality we have in these two volumes the history of nearly half those species whose life has been thoroughly investigated.

In comparing the habits of these larvæ with those of the nearly allied genus *Depressaria*, in which the history of fifty-two out of eighty-one species was known in 1861, Mr. Stainton arrives at some curious results with regard to what may be called their botanical distribution. Thus, whilst nearly half the known larvæ of *Depressaria* feed upon Umbelliferous plants, no single *Gelechia* is known to derive its nourishment from that order; the Compositæ, which nourish fourteen *Depressariæ* (out of fifty-two), have only ten *Gelechiæ* (out of 100) attached to them; the Leguminosæ are patronized by about twice the number of the latter in proportion to the former genus; and the Caryophyllaceæ, which are quite free from the attacks of *Depressariæ*, are known to harbour fourteen species of *Gelechia*.

It will be unnecessary for us to follow Mr. Stainton through his elaborate historical notice of the genus, or the histories of the twenty-four species here set forth; his mode of treatment of his subject must

be by this time well known to all entomologists. We can only wish him good speed in the continuation of his great work, and notice the fact that in subsequent volumes there will be some little departure from the plan hitherto adopted. The preceding volumes have often been seriously delayed by the difficulty of making up a set of histories of twenty-four species belonging to one or at most two genera; and this difficulty Mr. Stainton finds increasing upon him now that a considerable proportion of the species in some of the more extensive genera have been described and illustrated. In one instance, he tells us, a volume was kept waiting more than a year for the life-history of a single species. Under these circumstances he has resolved (we think judiciously) to give up the attempt to fill each volume with species of the same genus. We hope that he may receive the encouragement of a heavy subscription list.

The Tineina of Syria and Asia Minor. By H. T. STAINTON, F.L.S. 8vo. London: Van Voorst. 1867.

In the preface to the volume just noticed Mr. Stainton announces his intention of publishing a series of works upon the Tineina of various districts. The first of these, published early last year, is the little volume now before us, on the Tineina of Syria and Asia Minor; those in contemplation or in progress are on the members of the same beautiful group of Lepidoptera inhabiting Scandinavia, the Alps, and Southern Europe.

The inducement to the production of the present work was furnished by a collection of Microlepidoptera found in Palestine in 1865 by the Rev. O. Pickard Cambridge, and submitted to Mr. Stainton for identification and description. This led him to bring together all the papers published on the Tineina of western Asia, and to procure the loan of many of the type specimens; and in this volume we have the results of his investigations. It appears that, previously to Mr. Cambridge's visit, eleven collections containing species of Tineina had been made in Syria and Asia Minor by German travellers; and notices of these, with descriptions of new species, were published in various periodicals by MM. Zeller, Mann, and Lederer. Mr. Stainton has here reproduced the lists of species, and reprinted (in the original German) the descriptions of new forms, so as to bring into a focus, as it were, all the specially Levantine literature of the Tineina. To these he adds a catalogue of the species and descriptions of the new forms collected by Mr. Cambridge, descriptions of many of the species previously characterized by the above-mentioned authors, and of some other new species obtained from various sources. The number of species is 389, which are brought together in a table at the end of the book, showing, in parallel columns, the expeditions in which they were collected, with indications of their comparative abundance or rarity in the different localities.

Although unpretending in its form, this little work is one that must have taken no small labour in its preparation, and its importance is not to be measured by its bulk. In the present aspect of

natural history, no department occupies a more important place than that which treats of the geographical distribution of organized beings. It is from considerations founded upon this that nearly all the questions connected with the origin of species must be decided; and upon our solution of these depend, in great measure, our views of the philosophy of natural history. From this point of view it is almost impossible to overrate the importance of limited faunistic works, such as this of Mr. Stainton's; and its value is the greater as it relates to that remarkable region which constitutes the point of contact of the three great continents of the Old World.

The Fishes of Zanzibar. ACANTHOPTERYGII, by Lieut.-Colonel R. LAMBERT PLAYFAIR, Her Majesty's Political Agent and Consul at Zanzibar. PHARYNGOGNATHI &c., by ALBERT C. L. G. GÜNTHER, M.A., Ph.D., M.D. 4to. London: Van Voorst.

SINCE Adam Smith brought the phrase into vogue, the "division of labour" has been by most persons regarded with favour; but, somehow or other, naturalists were a long time before they found out the convenience of such an arrangement; and hence sprang a thick crop of controversies which had an awkward habit of developing into very pretty quarrels. May we hope that this contentious age has passed away, and that the outdoor observer, whose lamb-like virtues were aforesaid in our ears, has, once and for ever, lain down comfortably with the closet collector, undeterred by his leonine dentition and claws. In the work now before us the compact of eternal friendship is signed, sealed, and delivered (to the public) by personages no less than Lieutenant-Colonel Playfair, some time Her Majesty's Consul and Political Resident at Zanzibar, and Dr. Albert Günther of the British Museum. To say that they have succeeded in their undertaking is almost unnecessary; for that would of course be expected from the gallant Scottish gentleman who, until recently, superintended British interests on the East Coast of Africa, and the able German philosopher who presides over the "bottle-department" of the National establishment in Great Russell Street. But we think a word of recognition is also due to the authorities of the Bombay Government, who have most liberally encouraged the present work. Ichthyology has never been a popular branch of study, and in consequence ichthyological books have seldom been lucrative undertakings. Few but the initiated can distinguish at sight between a Cyprinoid and a Salmonoid, and fewer still give themselves the trouble to undergo the course of scientific study which such an initiation, to be well founded, properly requires. Goggle eyes and scaly bodies of unsightly form, sometimes beset by confusing appendages, sometimes free from them, but always immersed in a liquid more or less resembling the mixture which advertising wine-merchants term "Golden Sherry," are the sole reminiscences which most persons carry away with them after looking over a collection of fishes in a museum. This arises from the necessity of the case. We know not how to make an ichthyological cabinet attractive to the public, and

can hardly wonder at its general apathy on this subject. All the more credit, therefore, to those who have so laudably aided in the publication of the 'Fishes of Zanzibar!'

That the value of this work will be fully recognized by the scientific there need be no doubt; we therefore deem it less necessary for us to expatiate upon it. It will be sufficient to quote from the "Introduction," that hitherto

No attempt has been made to illustrate the Fish-fauna of that large extent of coast stretching between the Straits of Bab-el-Mandeb and Mozambique. The labours of Lieut.-Colonel Playfair go far to supply this hiatus. In the course of a residence of many years at Aden and Zanzibar, during which he made frequent excursions to the African coast and the adjacent islands, he formed a considerable collection of Fish, of which the following pages contain a description.

This collection contains 500 distinct species, obtained in the following localities:—

At Zanzibar	428
Mozambique	10
Seychelles	27
Comoro Islands	11
Aden and its vicinity	23
Chagos archipelago	1

We have thought it advisable that there should be only one authority for new species, on which account each of the authors has attached his name to a moiety of the work; but it must not be imagined that we have worked otherwise than jointly and continuously throughout.

In conclusion, we have only to offer our thanks to the joint authors of this work. Dr. Günther will of course pursue the noiseless tenor of his way, and continue to earn the gratitude of all zoologists by his unwearied labours; while Col. Playfair, we can scarcely doubt, will find at his new post something to glean, even though the officials of the "Exploration Scientifique de l'Algérie" have been harvesting before him. May they again join forces to produce another work as satisfactory as the 'Fishes of Zanzibar!'

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

December 5, 1867.—Dr. William Allen Miller, Treasurer and Vice-President, in the Chair.

"On some Alterations in the Composition of Carbonate-of-Lime Waters, depending on the influence of Vegetation, Animal Life, and Season." By ROBERT WARINGTON, F.R.S., F.C.S.

In carrying out through a series of years the principles of the aquarium for sustaining animal life in a confined and limited portion of water through the medium of growing vegetation*, I had observed that, during the summer months of the year, a consider-

* Quarterly Journal of the Chemical Society, vol. iii. p. 52.

able deposit made its appearance on the leaves of the plants and the glass front of the containing vessel, which was found to consist of carbonate of lime in a crystalline condition. This deposit formed a nidus for the growth of confervoid vegetation, which, at certain seasons of the year, increased very rapidly. These observations were alluded to at one of the Friday-evening meetings of the Royal Institution, March 27, 1857, when portions of the deposit were exhibited, and its composition demonstrated by experiment.

The formation of this deposit was then explained as arising from the fact that, as the summer season advances, and we have a longer continuance and also a greater intensity of the light of the sun, the absorption and consequent decomposition of carbonic acid by the plants is carried to a much greater extent, while the quantity of carbonic acid produced by the fish remains unchanged. The solvent of the carbonate of lime contained in the water being thus withdrawn, a deposit slowly takes place, incrusting the sides of the tank, particularly towards the light, where the confervoid growth, consequent upon it, accumulates in large quantities.

In continuing these observations, my attention was particularly arrested by the steady increase of deposition, attendant upon the renewed activity of the leaves, during the spring; and this determined me to ascertain by experiment the quantity of carbonate of lime existent in the water at fixed intervals during a long period of time. And inasmuch as the degrees of hardness, indicated by the measures of Clark's soap-test, presented a very ready, accurate, and simple means of arriving at this result, that mode of estimation was adopted, care being taken to displace any uncombined carbonic acid by agitating the sample with atmospheric air prior to the addition of the test, as directed by Dr. Clark, the indications or degrees thus obtained representing the quantity of lime-salts contained in an imperial gallon of the sample (70·000 grains of distilled water) in terms of carbonate of lime.

In order that the nature of the experiment may be more clearly understood, it will perhaps be better for me, before stating the results thus obtained, to describe briefly the construction and arrangement of the aquarium, its position, and its contents. The tank consisted of a rectangular zinc framing, twenty inches long by thirteen broad, and twenty-one in depth, having slate cemented into it at the bottom and sides, and being glazed at the back and front. It was filled with water to the height of twelve inches, or a volume equal to ten gallons, and on the slate sides were cemented, at the water-line, ledges of rockwork composed of sandstone and tufaceous limestone from Matlock, on which were planted a few ferns, chiefly *Trichomanes*, for ornament. The bottom of the tank was covered, for about two inches, with a mixture of sandy loam and gravel, into which several plants of the *Vallisneria spiralis*, the vegetable member of the arrangement, were inserted. Some large fragments of rough rockwork, principally limestone, were also placed upright on the bottom to break up the stiff outline of the square framing, and give a pleasing effect to the eye. The animal branch of the circle

consisted of four small crucian carp with a gold carp. Several freshwater mollusks, principally *Planorbis corneus* and *Limneus palustris*, were also introduced to act as scavengers and consume the decaying vegetation. The tank was loosely covered with a plate of glass, so as to allow of a free admission of the external air, and at the same time keep out a great deal of the soot and dust of the London atmosphere and impede the too rapid evaporation of the water. As the Trichomanes were stated to delight in shade, a thin muslin blind was placed over the covering glass.

The aquarium was located in a window-way having an eastern aspect, but, being surrounded within a few yards by the high walls of adjoining houses, the direct rays of the sun only reached it for about three hours in the morning during the months of June and July. It was established in January 1851, and has not since been disturbed, except by occasional supplies of distilled or rain-water, to replace the loss in volume arising from evaporation. It had been my custom to weed out the excessive growth of the *Vallisneria* during the summer, and also to remove some of the flaky deposit of calcareous matter from the surface of the glass nearest the light; but as I considered that such disturbances might interfere with the course of the investigation, these operations were discontinued.

The results that have been obtained from this investigation during the years 1861 and 1862 are as follows:—

		{ degrees of hardness, or grains of lime-salts, per imperial gallon, in terms of carbonate of lime.	
1861.	March 13	26·2	
	May 1	19·5	" "
	July 3	12·5	" "
	August 1	13·6	" "
	Sept. 17	15·0	" "
	Oct. 8	15·5	" "
	Nov. 12	18·0	" "
	Dec. 9	20·5	" "
1862.	Jan. 8	23·5	" "
	Feb. 8	25·0	" "
	March 3	23·0	" "
	April 3	21·0	" "
	May 2	19·0	" "
	June 4	16·5	" "
	July 4	14·0	" "
	August 5	12·0	" "
	Sept. 2	12·5	" "

The amount of calcareous matter dissolved will be seen to have steadily decreased during the spring and summer months, from its maximum in March 1861 and February 1862 to its minimum in July 1861 and August 1862, and then to have increased as steadily during the autumn and winter months.

Part of this hardness, however, unquestionably arose from the presence in the water of other salts of lime besides the carbonate.

To determine how much was the next point for investigation. Portions of the water were taken on several occasions and boiled for a considerable time, filtered, and the volume restored to its original bulk with distilled water. On examining these portions with the soap-test, it was found that the hardness was lowered to 5·6 degrees, equivalent to 5·6 grains of carbonate of lime. But inasmuch as carbonate of lime is soluble in water to the extent of 2·4 grains in the imperial gallon*, this will be reduced to 3·2 grains, which amount will therefore have to be deducted from each of the above results, in order to arrive at the true quantity of carbonate present in solution.

The maximum and minimum results will then stand thus :—

	CaO, CO ₂ in the imperial gallon.		CaO, CO ₂ in the imperial gallon.
1861. {	Maximum 23·0	1862. {	Maximum 21·8
	Minimum 9·3		Minimum 8·8

The data thus obtained will help to elucidate several very important and interesting phenomena in respect to all the three elements of the arrangement—the water, the fish, and the vegetation.

1. *The Water.*

The importance of growing submerged vegetation in maintaining waters, rich in carbonate of lime, in a meliorated state by diminishing their hardness has been clearly demonstrated by the foregoing data; and how necessary, therefore, it is that this association should be kept in view whenever a soft and healthful water is required for domestic purposes. Unfortunately this appears hitherto not to have been well understood, or at all events has been little attended to, since the very agent which has been provided naturally for effecting these beneficial results has been most commonly regarded as an evil, and studiously eradicated in all directions. These data will also explain the cause of the rapid growth of vegetation in well-waters rich in carbonic acid, when pumped into tanks or reservoirs and exposed to the full light of day. The plant-germs, naturally contained in the water or absorbed from the atmosphere, being supplied with an abundance of appropriate nourishment, rapidly vegetate, and the containing vessels, particularly during the summer months, soon become thickly coated with a dense confervoid growth.

It will also follow that all fish, as generators of carbonic acid, should be excluded from waters flowing over carbonate-of-lime strata, and intended for the supply of towns &c., as tending to increase their hardness. Of course the absence of calcareous matter would prevent such an effect taking place—a fact borne out by the well-known softness of springs and rivers flowing out of or over granite or sandstone rocks, even when thickly inhabited by the scaly tribe.

* Chemical Report on the Supply of Water to the Metropolis, June 17, 1861, by Messrs. Graham, Miller, and Hofmann; and Quarterly Journal of the Chemical Society, vol. iv. p. 381.

2. *The Fish.*

It is well known that water has the property of absorbing air from the surrounding atmosphere, and holding it in solution to the extent of from one-fortieth to one-thirtieth of its volume, not, however, without somewhat changing the proportion of its constituents; for when the absorbed air is abstracted from water it usually contains about thirty-two per cent. of oxygen gas, instead of twenty-one. This oxygen is converted by the respiration of the fish into carbonic acid, which is held dissolved by a still stronger affinity, the water being capable of retaining as much as its own volume of this gas in solution at the ordinary temperature and pressure of the atmosphere.

In the above-described arrangement the carbonic acid thus produced is absorbed by the submerged vegetation under the influence of the sun's light; the carbon is appropriated for its growth, while the oxygen is again liberated and held in solution by the water, provided the evolution is not too rapid, an effect produced by too great an exposure to the sun's light. When this is the case, much of the oxygen necessarily escapes into the air in a gaseous state and is lost. During the winter season, however, when the active functions of vegetation are to a great extent dormant, from the diminished quantity and intensity of the sun's light, the amount of carbonic acid produced by the respiration of the fish is greater than the plants are capable of consuming, and the excess must necessarily accumulate in the water. Were the production of carbonic acid confined to a short period, the water would doubtless right itself after a time, the poisonous gas passing away and fresh atmospheric air being absorbed. As, however, the production of carbonic acid is constant, this ameliorating action can have little effect; the water must remain always highly charged with carbonic acid. Here, then, its solvent action on the carbonate of lime, present in the rock-work and gravel, comes into play, and the hardness of the water is gradually increased in proportion as the light diminishes. Now, supposing for an instant that no carbonate of lime had been present in the arrangement, the question arises, what must then have ensued? The fish would have continued to respire, and would produce carbonic acid as before, which, remaining in a free state dissolved in the water, would unquestionably have had a most detrimental effect upon their health. Every one must have noticed the manner in which the golden carp confined in a globe of water, in which there is no growing vegetation to decompose the carbonic acid generated, or no limestone to combine with it, rise to the surface and continually gulp in the air required for their vital functions. Nothing whatever of this kind has ever been noticed in the aquarium under consideration, although the quantity of carbonic acid dissolved in the water has been at times very large.

From the experiments of Bischof*, we glean that the carbonic

* Bischof's 'Elements of Chemical Geology,' Cavendish Society's edition, vol. iii. p. 5.

has attained its greatest exuberance, namely, when the summer months are past and the light is beginning to decrease in its intensity and the days to shorten. So exactly, indeed, are the energies of the plants regulated by the amount of light to which they are exposed, that a constant arrangement, such as that here described, affords an excellent indication of the variation of the seasons in different years, or might even be made a rough measure of the total amount of light from month to month.

But while the demand for carbonic acid on the part of the plant varies in this manner with the seasons, the amount of that gas produced by the respiration of the fish is very nearly the same all through the year. Whence, then, does the plant obtain that additional quantity of food which its stimulated energies require during the spring and early summer months, and which its rapid and luxurious growth show to be readily supplied? After what has been stated, I think the source must be apparent to every one: it is the carbonic acid which has been gradually accumulated, and rendered innocuous to animal life from its being held in combination with carbonate of lime, in so marvellous a manner during the winter months. Stored up, yet held in feeble combination, a combination so weak that the vital forces of the fresh-growing vegetation can easily overcome it, and resolve once more into carbonate of lime, carbon, and oxygen the bicarbonate of lime contained in the water*.

Thus beautifully are the necessary irregularities in the purifying action of the plant compensated and provided for, that the balance of existence between the animal and vegetable organisms be not disturbed or overthrown, and thus additional proof is furnished, if such were needed, of the wisdom of that creative power that has ordered all things to work together for good, and by endowing certain bodies with such seemingly minute and insignificant affinities, maintains the glorious harmony of the whole.

MISCELLANEOUS.

Errata in Localities of Indian and Burmese Squirrels. Necessity of defining more exactly what is understood by India.

To the Editors of the Annals and Magazine of Natural History.

GENTLEMEN,—In Dr. Gray's very useful Synopsis of the Asiatic Squirrels in the Collection of the British Museum, published in the October number of the 'Annals,' some of the localities are incorrect. I venture to point out two or three such cases. I do not suppose that Dr. Gray is responsible for their accuracy, as he has doubtless taken them from the specimens in the British Museum; but, in any

* The rapid growth of submerged vegetation in rivers and waters containing a considerable amount of carbonate of lime must have been observed by all interested in the subject, in some cases obliging the cleansing of such streams three or four times during the year.

case, I have no doubt he will not object to my calling attention to the errors referred to.

1. *Sciurus Phayrei*, Blyth, is said to be from Malabar, on the authority of Mr. Blyth. It should be Martaban (in the Tenasserim provinces of British Burma); the species does not occur in India proper.

2. *S. chrysonotus*, Blyth, is from the Tenasserim provinces. See 'Catalogue of the Mammalia in the Museum of the Asiatic Society' (of Bengal).

3. *S. atrodorsalis*, Gray, was found by Mr. Blyth to be common at Maulmain. It certainly does not occur at Benares.

4. *S. Blanfordii*, Blyth, is not known from any part of India, nor from Pegu. It is, so far as is known, peculiar to Upper Burma, and my specimens were from within a few miles of Ava. How the mistake of ascribing this squirrel to India or Pegu has arisen I cannot understand. Mr. Blyth and myself are quoted as authorities for the localities. Now Mr. Blyth, in the two places in the 'Journal of the Asiatic Society of Bengal' in which he mentions the species, and also in the 'Catalogue of Mammalia in the Museum of the Asiatic Society,' distinctly gives Ava or Upper Burma as the locality, and I am certain I gave the same with the specimens which I presented to the British Museum.

There are a few other points in which Dr. Gray's localities differ slightly from those given by Mr. Blyth in the catalogue above cited (to the correctness of Mr. Blyth's localities in general I can bear testimony), but the differences are not of much importance. Those I have noted above are cases where the mistake extends to parts of different zoological provinces, which India and Burma are.

I feel sure, too, that there must be some error in attributing *Sciurus Finlaysonii* to Guzerat as well as to the neighbourhood of Java; and I very much indeed doubt if *S. vittatus* is found both in the Malay peninsula and in Ceylon.

I think it is much to be regretted that naturalists in Europe will not use the term India in a more definite and restricted sense. Dr. Gray, in this, follows the prevailing custom; but it is an objectionable one, I think. Thus I find India, Nepal; India, Nilgherries; India, Ceylon; India, Pegu and Upper Burma (!), as if all these places were equally included in India. I should have thought neither Ceylon nor Pegu would be considered parts of India; and I should much like to see Nepal excluded also, as it must be before the zoological characters of India proper begin to be properly understood. I may mistake Dr. Gray's meaning; if so, I beg to apologise for my error. The fact to which I allude is, however, notorious. It will, perhaps, be thought that India and Burma are parts of one zoological province. This is, I know, generally believed, and Dr. Günther has gone so far, in his 'Reptiles of British India,' as to join all the Malay countries, and even Southern China, with India proper. Indeed I believe that when I assert that the fauna of Hindustan, exclusive of the Himalayas and of the hills of Southern Indian and Ceylon, is quite as much African as Malay, I make a

statement no less novel than true. Yet a moment's reflection will show that a country abounding in wolves, foxes, hyænas, antelopes, bovine antelopes, and gazelles, bustards and sandgrouse, can scarcely be a part of the Malay or so-called Indian zoological province, where not a single representative of one of these animals exists. In this very instance, the squirrels attributed in error to India proper belong to a group shown by Mr. Blyth (Cat. Mam. Mus. As. Soc. p. 101, note) to be peculiar to the Indo-Chinese and Malay countries, and foreign to the peninsula of India with Ceylon. And that this most important fact of the mixture of African and Malay forms, the former prevailing in the plains, the latter in the hills, and perhaps on the Malabar coast of the Indian peninsula, is not recognized generally by European naturalists, I believe to be mainly due to the careless way in which specimens are labelled "India," when in reality they come from other parts of South-east Asia.

I am, Gentlemen, your obedient Servant,

Aden, Dec. 15th, 1867.

WILLIAM T. BLANFORD.

Preservation of Objects of Natural History.

To the Editors of the Annals and Magazine of Natural History.

GENTLEMEN,—I am not aware whether the following practical hint on the preservation of natural-history objects in glycerine is known or not; but, taking the risk of its being known, as it is a useful one, I send it for insertion in the 'Annals' if it be worth anything.

The specimens are to be soaked thoroughly for some days in the glycerine, the glycerine is then to be poured off, all but some five or six drops, and the bottle is to be well corked. I have by me some specimens of a species of *Vaginulus*, from Mauritius, which were, by accident, prepared in this way, and they look now (nearly one year since they were preserved) as fresh as they were on the next day after they were collected.

Of course the chief value of this method consists in its economy: and none who have tried glycerine as a preserving medium, but, I should think, would prefer it to alcohol; but the expense has hitherto been a bar to its common use.

I am, your obedient Servant,

WILMOT H. T. POWER,

Portland, Dorsetshire.

Assistant-Surgeon, 13th Light Infantry.

On Leskia mirabilis. By Dr. J. E. GRAY, F.R.S. &c.

Professor Lovén has received some specimens of this interesting Echinoderm, which I first published in the second series of this Journal, vol. vii. p. 134, and figured in the Catalogue of the Recent Echinidæ or Sea-eggs in the British Museum, t. 4. f. 4. They were obtained by Mr. Kinberg in the Indian seas between Singapore and Batavia. Dr. Lovén, in a paper in the Proceedings of the Swedish Academy for 1867, confirms the opinion that I expressed in the Museum Catalogue, that it is intermediate between the Spatangoid

Echinidæ and the fossil Cystidea of Von Buch, which are fossils chiefly confined to the Silurian region. Professor Lovén describes the animal at great length, and figures the mouth and vent; and he proposes to form for it a new section of Echinodermata, for which the name *Palæostomata* is proposed. The name *Leskia*, which I gave to the genus in honour of Leske, the echinodermist, had already been used for a genus of mosses and for one of Diptera. Prof. Lovén, being adverse to the changing of my name, suggested that I should give the genus another one, when he was in London; but the subject was forgotten. I would therefore now propose that *Leskia* be changed to *Palæostoma*.

Macacus lasiotus, a new Ape from China.

The Zoological Society has just received an interesting new Ape from Szechnen, in the interior of China, intermediate in appearance between the Tailless Ape of North Africa and the Rhesus Monkey.

Macacus lasiotus.—Tail none; ears ovate, exposed, and covered with hair; fur yellow olive, redder behind and greyer beneath; skin near callosities crimson; face whitish, with a small red spot on the outer side of each orbit. *Hab.* China.—J. E. GRAY.

Additions to the Zoological Collection in the British Museum.

The Zoological Collection in the British Museum has received a million of specimens since 1837, when the registration of the specimens was commenced under the charge of the present keeper, Dr. Gray. The specimens have almost all been acquired by purchase; and they have invariably been selected, primarily, to complete the series of specimens of each class, and especial trouble has been taken to acquire the original type specimens from which the species have been described, and, secondly, to show the geographical range of each species, taking great care to prevent the collection being encumbered with any useless duplicates. The average yearly increase has been about 36,000 specimens.

On Pteronura Sanbachii, an Otter from Surinam.

By Dr. J. E. GRAY, F.R.S. &c.

The British Museum has lately received a large female Otter with its cub, from Surinam. It is a fresh specimen of the animal that was described and figured many years ago in this Journal as *Pteronura Sanbachii* from a young specimen in the Museum of the Royal Institution, Liverpool, which has remained unique until the present time. The sides of the tail and feet in the Liverpool specimen had been artificially depressed and unduly stretched out by the preserver. In the natural state the tail is rounded and only marked with a rounded ridge on each side. The Surinam Otter has a hairy nose, large feet with bald soles, a thick, rather depressed, tapering tail, with a subcylindrical raised border on the middle of each side, which is covered with hair like the rest of the tail, and a large tuft of hair

on the outside of each ankle. It is a large Otter, nearly 5 feet long. The fur is beautifully soft, of a golden-brown hue, with a white streak on each side of the throat.

Artificial Hybridization in the Genus Gossypium.

By J. E. BALSAMO.

In the province of Terra d'Otranto, one of the most southern districts of Italy, the cotton-tree has been cultivated from time immemorial. The processes of cultivation there generally followed are well adapted to the nature of the plant, and in this particular there is nothing to be changed: but the species of cotton-tree are not so well selected; for although the short-stapled *Gossypium herbaceum* is not much cultivated, but more commonly the *G. hirsutum*, which is preferable as regards its textile qualities, this is far from having the length, fineness, softness, and lustre of the cotton of *Gossypium barbadense*, commonly known as Sea-island or long-staple cotton. During the American war I experimented upon many American varieties of cotton, particularly the Sea-island, New Orleans, and Louisiana, and I distributed a great part of the seed which I obtained among the cultivators of my province. The last two of these varieties, which, from some of their characters, may be referred to the Siamese type, prospered; the Sea-island, which is less hardy and ripens later, did not succeed. Most of its capsules open in the months of September and October; and the rains of autumn spoil its fibre. It then occurred to me to unite the two types with long and short staples, in the hope of obtaining a variety of cotton which should combine the precocity and hardiness of the Louisiana or Siamese with the length, fineness, and silky lustre of the Sea-island cotton. The six hybrids and mules which I present to the Academy, taken from among many others which I have obtained, are derived from the harvest of last summer, and are crossings of *Gossypium hirsutum* of the improved white Siamese variety, and of the variety with red or nankeen cotton, with *Gossypium barbadense*. I purposely selected the nankeen, because, as it is reddish, we may the better judge of the predominance of the red or white type of the parents by the different shades of the hybrid cottons. This is the most striking character for those who are not accustomed to distinguish the organic, botanical, and physical differences of hybrid products.

Each species of cotton-tree has five petals and a great number of monadelphous stamens, all bearing anthers, and surrounding the pistil at different heights. They seem to be so many radii implanted obliquely upon the central cylinder or bundle formed by the styles. There are as many styles as stigmata, and they may easily be separated with the point of a penknife. They may be recognized by the naked eye in the form of three, four, or five delicate nervures, united together on the inside. The number of cells in each capsule invariably corresponds to that of the styles; it is therefore of importance to select the capsules which have the greatest number of cells, in order to obtain a greater number of tufts of cotton.

The oblique position and nearly radiating arrangement of the stamens renders artificial fecundation difficult, in consequence of the difficulty of cutting them all down to the bottom of the calyx and removing them without the falling of a little seminal dust upon the stigmata. Nevertheless I have succeeded in avoiding the contact of the anthers with the latter, and in transporting the pollen to the pistils of flowers from which I had removed all the stamina. I took the precaution of cultivating the species intended for mutual fecundation at a distance from each other, and of waiting for the moment of the escape of the pollen, which usually takes place about noon, when the flower opens. Hence the hottest hours of the day are those of the dehiscence of the stamina. During and after fecundation the petals close again, the stamina acquire a more vertical position, and the pistil lowers its stigmata towards the stamina which are beneath it; the corolla changes from yellow to rosy red, and on the following day it falls withered. If it happens to rain on the day of the flowering of the cotton-tree, the water which remains in the flower alters and blackens the pollen; in that case natural fecundation itself may fail, and the withered flower does not fall, or falls very late. Strong winds, by carrying off the greater part of the pollen, may also cause natural fecundation to be imperfect; in this case the capsule remains rudimentary, withers, and falls in a few days.

My six hybrid plants, obtained from the nankeen cotton-tree, fecundated by the pollen either of the Siamese cotton-tree or of *Gossypium barbadense*, and from *G. barbadense* fecundated by the pollen of the nankeen cotton-tree, show in the colour, softness, elasticity, and length of the fibre, in the nakedness of the seeds and the form of the leaves, their relation to the two types which produced them. It is as well to state that in the floral organs of these hybrids I have not observed any deformity or modification, except that the nervures of the style present a helicoidal deviation at the extremity.

Being engaged with cotton-trees, I wished to study the influence of light upon the germination of their seeds. I selected those of *Gossypium barbadense*, which are black, and more easily followed in the changes which they undergo during germination. I made use of a large glass vessel, into which I put a homogeneous vegetable soil. I introduced cotton-seeds at different depths, in such a manner that, being in contact with the inner wall of the vessel, I could see one side of them from without. A portion of these seeds were protected from the chemical rays of light by means of pieces of yellow paper pasted on the outside at the points corresponding to the seeds; the rest were left freely exposed to the light. The vessel was in the open air, and was watered every three days. This experiment was commenced on the 15th May; on the 24th the seeds covered by the paper began to show the radicle and the plumule, whilst those exposed to the light did not show the least sign of germination. The former thrived in their vegetation; the others, when taken out in ten days' time, appeared sensibly altered. It appears, therefore, that light is injurious to the germination of the cotton-tree.—*Comptes Rendus*, November 4, 1867, pp. 763-766.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 3. MARCH 1868.

XXIII.—*On the New Bat (Amblyotus atratus) discovered by Prof. Kolenati.* By L. H. JEITTELES*.

SOME astonishment was excited in the scientific world when the late Professor Kolenati, of Brünn, in 1858 published (in the Sitzungsber. der Wiener Akad., mathem.-naturw. Klasse, xxix, pp. 250–256) the description of a Bat discovered by him on the Altvater, and which he not only regarded as a new species in the South-European fauna, but actually set up as the type of a new genus. Could it really be possible, in the middle of the nineteenth century, to discover new *species* and even new *genera* of Mammalia in the heart of Europe? This seemed, even to many scientific men, so incredible that they felt themselves obliged to oppose more or less doubt to the very existence of this newly described animal, which, moreover, has remained undetected even to the present day in any other region of Germany, and to assume that there had been some error in the determination. I must admit that I also was not disinclined to partake of these doubts; and I was the more induced to do so, as one of the greatest living European authorities on the Mammalia expressed an opinion, in a letter to me, that Kolenati's new Bat might probably be only *Vesperugo Nilssonii*, Blas. During my residence in Olmütz I took pains to obtain Bats from the Altvater, in order to be able to form an opinion for myself, from my own investigations, as to this doubtful new mammal. By the kindness of M. Theisler, at that time tutor in the house of M. Primavesi, a merchant in Olmütz, and who passed a great part of the summer of 1864 in Gräfenberg, I obtained at last a Bat (found on the 11th of August, 1864, in the daytime, under a stone near the Swiss dairy on the Altvater) from the careful examination of which I con-

* From the fourth Programm der N.-ö. Landes-Oberrealschule zu St. Pölten.

The cutting-edges of the lower incisor teeth stand in the direction of the jaw. The outer (second) upper incisor is not quite so high as the outer point of the bicuspid inner (first) tooth, and is strikingly weaker than the first tooth in its transverse section. The upper canines are remarkably large, nearly twice as long as the lower ones. In the upper jaw there are four, and in the lower jaw five molar teeth on each side. The first inferior molar is nearly one-half lower than the second.

On the spur-bone there is a very inconsiderable membranous lobe, measuring only $\frac{1}{2}$ millim. at its broadest part; this does not project angularly, but runs parallel to the spur-bone, or, rather, becomes very gradually narrower and terminates about the middle of the spur-bone. This membranous lobe is so slightly developed that it may easily be overlooked on a cursory examination, but it nevertheless exists.

The wing-membrane is attached as far as the roots of the toes. The tip of the tail stands freely out of the membrane.

The colour of the long fur is dark brown above, yellowish beneath. The hairs are of two colours, both above and below, the base dark blackish brown, the apical third above and the apical half below light yellowish brown. The apices of a portion of the dorsal hairs have a nearly golden lustre. The interfemoral membrane is furnished with tolerably close, uniformly brown hairs, without golden lustre. The ears, muzzle, and wing-membrane are dark brownish black.

The animal here described by me consequently agrees very well (leaving out of consideration the shorter whiskers) with the description of Kolenati's *Amblyotus atratus*, with the exception of two characters. My specimen has a very narrow, but still unmistakeable membranous lobe on the spur-bone; and the second joint of the fourth finger is much longer in proportion to the third, in my individual, than accords with Kolenati's description, as my measurements of the joints in question are 7.5 and 12.5 millims., and Kolenati's 9 and 19 millims.

The question now was whether this Bat could not be referred to some previously known species. From the number of molar teeth it could only be referred to *Vesperugo Nilssonii*, Keys. & Blas., or to *V. discolor*, Natt. But from *V. Nilssonii* the animal from the Altvater is distinguished by the lower incisor teeth standing quite distinctly in the direction of the jaw, and by the second upper incisor being lower and far weaker in proportion to the first; from *V. discolor* by the smaller height of the first upper incisor, which in the Altvater Bat is scarcely once and a half the height of the second tooth, whilst its outer point is, indeed, somewhat higher than the second incisor, but

at the same time much lower than the inner point of the first tooth,—also by the termination of the outer margin of the ear neither below the line of the cleft of the mouth, nor close to its angle, and, finally, by the golden lustre of the dorsal hairs. And, from both species, *Amblyotus atratus*, Kolen., differs most strikingly in its foldless ears and in the formation of the tragus, which is quite different from that of any other species of *Vesperugo*. From *Vesperugo maurus*, Blas., with which the Altvater Bat agrees in respect of the golden lustre of the dorsal hairs, it differs in the position of the lower incisor teeth, in the want of the second unicuspid molar in the upper jaw, and in the structure of the ear.

Kolenati's new Bat consequently really forms a good species. And the establishment of a new genus also appears to be justified, as this Chiropter differs, in the structure of the ear and the very inconsiderably developed membranous lobe of the spur-bone, from all other species of the genus *Vesperugo*, Keys. & Blas., and likewise from those of the genus *Vespertilio*, Linn.

The generic character of *Amblyotus*, Kolenati, should therefore be as follows :—

“Above four, beneath five molar teeth on each side. Ears without folds, with the outer margin terminating in front of the tragus. Tragus convexly curved at the upper third of its inner margin, with the rounded extremity bent upwards and outwards. The spur-bone on the hind foot bears an extremely narrow, straight, lateral membranous lobe.”

From this it appears that this genus, as already remarked by Kolenati, constitutes a true intermediate form between the genera *Vesperugo* and *Vespertilio*.

The species *Amblyotus atratus*, Kolen., may be thus characterized :—

“Ears much shorter than the head. Wing-membrane attached to the base of the toes. Tip of the tail freely projecting from the interfemoral membrane. Edges of the lower incisor teeth standing in the direction of the jaw. First upper incisor bicuspid, rather higher, and in transverse section much stronger than the second. Muzzle broad and obtuse, sparsely hairy, black. Dorsal hairs with golden lustre.”

I have still to express the opinion that this remarkable animal may be a hybrid, possibly of *Vesperugo Nilssonii* or *discolor*, and a species of *Vespertilio*, perhaps *V. Daubentonii* or *mystacinus*.

XXIV.—*Observations on Sponges and on their Arrangement and Nomenclature.* By Dr. J. E. GRAY, F.R.S., V.P.Z.S., F.L.S., &c.

I READ before the Zoological Society, in May last, some Notes on Sponges, in which I gave a Synopsis of the different arrangements that had been proposed for Sponges, and suggested a new one by which I hope that any one who will collect together the spicules of any specimen of sponge will be able at once to determine the order and family and also the genus to which it belongs.

As the proposed system contained many innovations, it has produced some discussion and opposition, which was to be expected. In the following observations I have attempted to meet the objections that have been made by various persons. As these persons generally take Dr. Bowerbank's 'British Sponges' as their text, I fear my observations will appear as if chiefly directed against that work. They are made, however, in the cause of science and in the hope of rendering the structure and arrangement of Sponges better understood, and not in the least from any ill feeling towards the author, for whom I have great personal regard.

Until the publication of Dr. Bowerbank's Essay in the 'Philosophical Transactions' and Dr. Oscar Schmidt's work on the Sponges of the Adriatic, no attempt was made to arrange Sponges into genera based on their structure and organization, or to arrange the genera into natural groups. Bowerbank's series of papers commenced in 1858; but the systematic part of these works appeared nearly simultaneously in the year 1862.

Nardo, it is true, studied the Sponges of the Adriatic, and some years before proposed an arrangement of them; but he never published any characters for the genera or species which he names; and his names are only known by prescription or to those who may have received specimens named by him. Dr. O. Schmidt uses some of Nardo's generic names, giving characters to them, and in some cases evidently restricting their significance. Such genera can only date from their publication in Dr. O. Schmidt's work—that is, from 1862.

One of the most careful and intelligent students of the lower animals in this country, whose name often appears in the 'British Sponges' (not observing that Dr. Bowerbank's and Dr. O. Schmidt's works on the genera of Sponges were published simultaneously in 1862), speaking of Dr. O. Schmidt's work, observes:—"Bowerbank, in the most extraordinary fashion, has completely ignored everything that has been written on the

Continent, and in this and in many other particulars it is most unsatisfactory." The author of the 'British Sponges' is himself partly to blame for this misconception. Though the writer above referred to places "Bowerbank" after each generic name (as he does after almost every specific name), he does not refer to his paper in the 'Philosophical Transactions' for 1862, in which they were first defined and published. Indeed I believe that many possessors of the 'British Sponges' have no idea that the first volume at least is only a reprint of the papers in the 'Philosophical Transactions,' with inferior copies of the plates; and therefore they may be easily misled so as to believe that the genera date only from the issue of that work.

Dr. Bowerbank's work is a rich mine of observation; and it is astonishing that a naturalist who has collected so many important facts and figured so many spicules should have formed such orders and genera, and have described his species in a manner so incomprehensible. I believe this chiefly arises from his having set himself to work to make an arrangement and nomenclature of the spicules which are in his collection of microscopic slides, rather than to study the sponges themselves. His entire absence of any knowledge of physiology leads him into most extraordinary theories about the uses of the spicules and the organization of the sponges, which are chiefly propounded in his introductory chapter, but equally deform his specific descriptions. In fact he undertook a work that required considerable scientific acquirements without any preliminary training.

In the 'British Sponges' the spicules are divided into seven classes, which are again subdivided and at length separated into several hundred kinds, some of them with names long enough almost to take away one's breath to pronounce them; and most of these are figured. After all this labour, the forms of the spicules are never used as generic characters. The genera often contain spicules that belong to what he considers different classes. Though the differences of the spicules found in each species form the principal part of the specific descriptions, the author does not even think it necessary to refer to the figures on his plates which represent the spicules he describes—which is to be regretted, as there can be no doubt that a reference of this kind would have rendered his descriptions more intelligible. In fact the author seems to have collected more material than he knew how to employ, like a soldier with a great stock of ammunition that he does not know how or fears to use.

In the system of Sponges which I have proposed, certain

families are determined by the presence or absence of certain kinds of spicules. Thus, in the more inconspicuous siliceo-spicular Sponges, the presence of bianchorate or birotulate spicules characterizes *Esperiadæ*, and of stellate spicules *Tethyadæ*; both kinds are absent in *Halichondriadæ*. Now Dr. Bowerbank's own specific descriptions show that some of his genera contain species belonging to two, and some to all of these three families; yet he does not use the presence or absence of these spicules to divide the genera into sections, though in his preliminary chapters he shows that he believes the stellate and bihamate spicules have an important use in the habits and economy of the animal.

The following analyses of these genera show the details of this statement:—

Almost all the *Dictyocylindri* belong to *Halichondriadæ*; but *D. fascicularis* and *D. stuposus* have stellate spicules, and belong to *Tethyadæ*.

Hymenaphia vermicularis and *H. clavata* belong to *Halichondriadæ*, and *H. verticillata* and *H. stellifera* are *Tethyadæ*, having stellate spicules.

The three species of *Hymedesmia*, for example, belong to three families—*H. radiata* to *Halichondriadæ*, *H. stellata* to *Tethyadæ*, and *H. zetlandica* to *Esperiadæ*.

Six out of the eight species of *Microciona* have anchorate spicules and belong to *Esperiadæ*, and the others, *M. lævis* and *fallax*, to *Halichondriadæ*, having only fusiform spicules.

Of the genus *Hymeniacion*, which contains thirty-nine species, by far the greater part belong to *Halichondriadæ*, one to *Cloniadæ*; but there are scattered among them (why, I cannot comprehend) nine belonging to *Esperiadæ*, as (9) *H. perarmatus*, (15) *H. variantia*, (16) *H. macilenta*, (24) *H. lingula*, (25) *H. floreum*, (27) *H. plumosa*, (28) *H. jecusculum*, (33) *H. subclavata*, and (37) *H. paupertas*,—one, (39) *H. Bucklandi*, to *Tethyadæ*.

Of the twenty-eight species of *Halichondria* more than half do not belong to *Halichondriadæ*: thus (8) *H. angulata* is a *Tethyad*; (9) *H. corrugata*, (10) *H. Thompsoni*, (11) *H. forcipis*, (14) *H. incrustans*, (15) *H. candida*, (16) *H. irregularis*, (17) *H. Dickiei*, (18) *H. Pattersoni*, (19) *H. pulchella*, (20) *H. Ingalli*, (21) *H. scandens*, (22) *H. Batei*, (23) *H. granulata*, (24) *H. Hyndmani*, (25) *H. nigricans*, (26) *H. albula*, and (28) *H. inornatus* belong to *Esperiadæ*.

Isodictya is the great magazine genus of the work: it contains no less than forty-three species; about two-thirds of them belong to the family *Halichondriadæ*. The following—

(15) *I. jugosa*, (20) *I. robusta*, (25) *I. palmata*, (31) *I. Normani*, (32) *I. fucorum*, (33) *I. Alderi*, (34) *I. Edwardii*, (35) *I. lobata*, (36) *I. paupera*, (38) *I. Clarkei*, (39) *I. gracilis*, (41) *I. Beantii*, (42) *I. lurida*, (43) *I. fimbriata*, belong to Esperiadæ.

With such a mixture in each of the genera, one is not astonished to hear, as one often does, that it is utterly impossible to make out any sponge by Dr. Bowerbank's work. Believing that the work contains much that is valuable, I have done what I could, in the paper published in the Proceedings of the Zoological Society, to make it useful to the British zoologist, among other ways by referring to the plates in which the spicules of his species are figured.

Dr. Bowerbank prides himself on having proved that eleven of the fifty-six species of British Sponges described by Dr. Johnston "are only repetitions with new names, or otherwise no species" (Brit. Sponges, i. p. 2). Further on, at p. 222, he shows his reasons for these reductions. It remains to be seen how many of the 193 British species described by Dr. Bowerbank will suffer the same fate at the hands of his successors in the study of this group of animals.

It would be very premature, with the very imperfect knowledge we possess, to attempt to give any arrangement showing the relations that the genera have to each other, though one cannot study them without observing that no linear arrangement that can be formed will show more than a few of such relations, and must separate some genera which appear to have considerable analogy, if not affinity, to each other.

The Coral Sponges (*Coralliospongiæ*), for example, are closely allied to the *Euplectelladæ*, the genus *Aphrocallistes* forming a passage between *Dactylocalyx* and *Euplectella*. The Coral Sponges and the *Euplectelladæ* are peculiar among Sponges for having the sarcode studded with long-rayed stellate spicules. And it would not be difficult to point out a number of such alliances; but this must be deferred until we have more works like the 'British Sponges' and the 'Sponges of the Adriatic Sea.' I am very glad to hear that Dr. Oscar Schmidt is now engaged on the Sponges of the Mediterranean, and especially of Algeria, and hope he may hereafter be induced to take up the exotic fibrous Sponges.

It has occurred to me that if I abstained from dividing the Sponges into Netted and Spicular Sponges in my arrangement, and commenced by separating them according to the spicules, as I had divided the Spicular Sponges, the arrangement of the families would be simplified and more natural, as

the Coral Sponges would be placed near the Euplectelladæ, thus :—

Section I. MALACOSPONGIÆ. Soft-spored Sponges.

Subsection I. LEIOSPONGIÆ. Spicules none, or, when present, of only one kind.

Order I. KERATOSPONGIÆ (Horny Sponges), including the families Spongiadæ &c.

Order II. RAPHIOSPONGIÆ (Needle Sponges)—that is, the order Leiospontiæ of my Table, including Halichondriadæ &c.

Subsection II. ACANTHOSPONGIÆ. Spicules always present, of more than one form, akin in each Sponge.

Order III. CORALLIOSPONGIÆ (Coral Sponges). Spicules anchylosed by siliceous matter, as Dactylocalycidæ, Aphrocallistidæ, Euplectelladæ.

Order IV. ARMATOSPONGIÆ (Armed Sponges). Spicules distinct, more or less immersed in horny or fleshy matter. Includes Esperiadæ and Tethyadæ.

Subsection III. ARENOSPONGIÆ, or Sand Sponges, &c.

Dr. Bowerbank has complained to me that I have erroneously described the Coralliospontiæ as formed of "siliceous spicules anchylosed together by siliceous matter, forming a netted mass." He says that I have confounded *fibre* with *spicule*. As the siliceous spicules are of the same structure, whether they are short and thick, or very long cylindrical filaments like those of *Euplectella*, I can see no reason why they should not all be called spicules.

Dr. Bowerbank states that fibres always anastomose and form a network, spicules never do so. According to this rule, some of the spicules of the *Euplectella* do anchylose and some do not; so that some should be called spicules and others fibres. Perhaps this is why Dr. Bowerbank speaks of the "long siliceous spicula or fibres of *Euplectella*" (Brit. Spong. i. p. 9).

Hence Dr. Bowerbank characterizes the Coral Sponges as having a siliceo-fibrous skeleton (B. S. i. p. 203); and he remarks that the structure and mode of growth in this suborder of siliceo-fibrous Sponges "appears to be precisely the same as that of the cerato-fibrous sponges" (*ibid.*).

This is true to a certain extent, as the spicules of the siliceous and the fibres of the horny sponges are each secreted by the animal and deposited in successive layers, and merely differ in the quantity of animal or horny and of siliceous matter that they contain. Some spicules are almost all silica, with scarcely any horny matter, and some horny fibres almost

all horny matter, with scarcely any appreciable silica; but in a large collection of spicules from different sponges the two forms pass into each other almost insensibly. I must consider that the Coralloid Sponges are sponges which have the siliceous spicules anchylosed together by siliceous matter; some of the fibrous sponges consist of siliceous spicules cemented together by horny matter, and others of horny matter only, without any imbedded spicules—the only difference between the two extremes being the abundance of silica in the first and the more or less entire absence of it in the last kind; so that it is a matter of little importance whether they are called spicules or fibres.

Dr. Bowerbank's considering the distinction of so much importance perhaps leads him into the following extraordinary observation:—"In the solid siliceous fibres of *Dactylocalyx*, fig. 274, pl. 15, and in the tubular siliceous fibres of *Furreea occa* (Bowerbank's MS. fig. 277, pl. 15), and especially in the latter, we observe a very much closer approximation to the tubular form of the bones of the higher classes of animals" (B. S. i. p. 28). Dr. Bowerbank has odd notions respecting the analogies between the parts of sponges and vertebrate animals: thus, in the characters of *Geodia*, he speaks of pores furnished with "oesophageal tubes" (B. S. i. p. 167).

Dactylocalyx pumicea was well described by Mr. Stutchbury in the Proceedings of the Zool. Soc. for 1841, p. 86, from a specimen that had been sent from Barbadoes to the Bristol Museum. Mr. Stutchbury most kindly let me have half of the Bristol specimen which he described, which is now in the British Museum. Dr. Bowerbank repeatedly refers to this species, under Stutchbury's name, in his 'British Sponges' (see pp. 204, 274, &c.). There is a similar sponge in the Museum of the Jardin des Plantes, where it is called "*Iphiteon panicea* (*Dactylocalyx*, Stutchbury)," a gemmule of which is represented by fig. 341 of Dr. Bowerbank's 'British Sponges.' Some years ago I obtained from the late Mr. Thomas Ingall a beautiful small specimen of this sponge, which he had received from St. Vincent, in the West Indies, where, I believe, it was obtained by Mr. Lansdown Guilding. Mr. Ingall informed me that he bought it with a number of sponges in a very dirty condition at the sale of Mr. Guilding's specimens in King Street, Covent Garden. Dr. Bowerbank, at p. 259 of his first volume of 'British Sponges,' observes, "[The spinulo-quadrifurcate hexradiate stellate spicules] occur abundantly in a beautiful and unique specimen of a cup-shaped siliceo-fibrous sponge formerly in the cabinet of my friend Mr. Thomas Ingall, now in the British Museum." This spe-

cimen is figured by me in the Proc. Zool. Soc. 1867, t. 27. f. 2. Dr. Bowerbank calls this specimen *Dactylocalyx Ingallii*, never observing that it is identical in every respect with the *D. pumicea* of Stutchbury and the *Iphiteon panicea* of Valenciennes; so that Dr. Bowerbank formed two species out of the same, regarding the second specimen as a unique sponge; and I am by no means certain that he does not think *Iphiteon panicea* a third one, as he only records it as belonging to the genus *Dactylocalyx* of Stutchbury, without mentioning its being the same species.

It is to be observed that though I have Dr. Bowerbank's own authority for regarding *MacAndrewia azorica* as identical with *Dactylocalyx Prattii*, at p. 79 he observes, "The external characters of these fibres vary in each species. In a new siliceous Sponge in the British Museum, designated by Dr. Gray *MacAndrewia azorica*, the fibres are quite smooth, as represented by fig. 274, pl. 15; but in the greater number of species they are more or less tuberculated, as in fig. 275, pl. 15, which represents a group of fibres from the type specimen of *Dactylocalyx pumicea*, Stutchbury, a portion of which is in the possession of Dr. Gray; in other species in my possession the tuberculation is very strongly produced, as represented in a few fibres of *Dactylocalyx Prattii*, Bowerbank's MS., fig. 276, pl. 15" (Brit. Sponges, i. pp. 78, 80). These observations are repeated at p. 204.

I quote these observations as showing that spicules are liable to variation within certain limits, most likely peculiar to each species, and that the idea of separating certain sponges because a slight difference in the surface of the spicules may be shown in two microscope-slides is exceedingly fallacious. In fact I am convinced, from the examination of many specimens, that spicules vary quite as much as the external form of the sponge, whatever those microscopists who confine themselves to the examination of slides may say.

MacAndrewia azorica was first described and figured by me from a specimen collected by Mr. MacAndrew at St. Michael (Azores), in the Proc. Zool. Soc. for 1859, p. 438, pl. 15. Dr. Bowerbank quotes my name, adding a needless *s* to it, in 'British Sponges,' i. p. 204, f. 274; at p. 237, f. 53, he calls it *Dactylocalyx Bowerbankii*, Johnson, from a specimen collected at Madeira by Mr. Johnson. Both these specimens are in the British Museum, and there can be no doubt of their identity. But at p. 18 of the same volume Dr. Bowerbank mentions "a new species of siliceo-fibrous sponge from India, *Dactylocalyx Prattii*, Bowerbank, MS." The name is repeated at pp. 19 & 20, and occurs again at pp. 204, 274, 278, where

the spicules are figured, viz. f. 52, 276, 278, & 306. I have Dr. Bowerbank's authority for considering the latter a synonym of *M. azorica*, he, when examining the specimens in the British Museum, having brought to me as a good example of his *Dactylocalyx Prattii* the specimen I described and figured, not recognizing it as the Sponge to which he had already given two other names (I believe the Indian habitat is a mistake); so that this Sponge has been referred to two genera and regarded as three species by Dr. Bowerbank.

I suspect that these errors arose from Dr. Bowerbank's habit of working from microscopic preparations, often made by his friends Mr. Tyler and Mr. Lee as well as by himself, from fragments which they obtained from various collections, under different names, without Dr. Bowerbank taking the trouble to compare the specimens from which they were obtained. If mistakes such as these arise in well-marked Sponges like *MacAndrewia azorica*, what may not occur in obscure, inconspicuous, nearly allied British Sponges?

Dr. Bowerbank informs me that *Placospongia melobesioides*, Gray, P. Z. S. 1867, pp. 128 & 549, is the "*Geodia carinata*," Bowerbank, MS., mentioned, but without any description otherwise than that there occur in its interstitial membranes "multiangular cylindrical" spicules, in common with another Sponge in the British Museum (see Phil. Trans. 1858, p. 314, and Brit. Spong. i. p. 239, f. 71, & p. 254), as having abundant "arborescent elongo-subsphæro-stellate spicules" (see f. 163). Such names cannot have any claim to be used as having any priority; indeed I cannot suppose that Dr. Bowerbank would propose that they should; for he repeatedly objects to other authors that they do not define their genera or species. Thus:—"Although the Sponge was designated *Dactylocalyx pumicea*, no generic characters were given; I propose therefore to characterize it as follows" (B. S. i. p. 203). "Professor Owen has not attempted to characterize his own genus" (*Euplectella*) (B. S. p. 175). "Grant, I believe, gave no generic description of *Cliona*" (B. S. ii. p. 221). This observation is the more remarkable as Dr. Bowerbank quotes, just before this remark, the excellent generic character given by Mr. Stutchbury, which is far better than that proposed by Dr. Bowerbank himself; for if he had adopted it, he would not have placed in the genus the incongruous *D. Prattii* = *MacAndrewia azorica*.

The system of giving a number of names without any description, which is to be found in Dr. Bowerbank's 'British Sponges' and Essay, is a very bad one. It is loading the list with a quantity of names which may very probably never

come into use; for if the author is too idle to describe them when he names them, and therefore defers doing so, it is very likely that he will never have the time or the inclination to do it. The insertion of these MS. names is so easy that the writer may give names to specimens without sufficient examination for ascertaining if they are distinct. Dr. Bowerbank has fallen into this error repeatedly, as I have pointed out in this paper. In the first two pages of the explanation of the plates, vol. i. pp. 229, 230, *Halichondria coccinea*, Bowerbank, *H. Alderi*, Bowerb., *H. crustula*, Bowerb., and *H. variantia*, Bowerb., are each mentioned. I do not find any of them described. They are probably British species to which other names have been given. The last may be *Hymeniacion variantia*, Bowerb. Brit. Spong. fig. 174; but no reference is made to the figure or the name.

Dr. Bowerbank, because he has found that the Sponge attached to a single specimen of *Hyalonema lusitanicum*, out of twelve that have been obtained belonging to the genus *Carteria*, has the same spicules as the Sponge attached to the Japanese *Hyalonema*, concludes that the two species are only one, and blames me for having formed them into two genera. He has entirely overlooked the fact that the barks of the Portuguese and Japanese species are of very different texture, that the animals when contracted are of very different form (the one circular and the other oval), and that they have a different number of tentacles, in one placed in a double, in the other in a single row. Now, whether the polype forming the bark is a part of the coral or a parasite is a matter that may be open to discussion; but the difference in the structures of the polypes is sufficient to distinguish them from each other as species or genera.

But it is not astonishing that Dr. Bowerbank should overlook such differences; for he seems to have the faculty of seeing what he desires, and of not seeing what he does not wish to see. Thus, for example, he persists in denying the existence of the tentacles and cnidia in the polypes of the genus *Hyalonema*, though they have been figured by Brandt, Schultze, and Bocage, and have been seen by hundreds of persons at the late soirée of the Microscopic Society, where they were exhibited by Mr. Lee, Mr. Steward, and several other microscopists.

I am not convinced of the identity of the Sponge found attached to the Japanese and Portuguese specimens of *Hyalonema*. Professor Bocage sent me a fragment of the Sponge attached to the Portuguese *Hyalonema*. I examined it very carefully, and could only find needle-like spicules, without

defensive spicules of any form. The fragment was a very minute one, and it might be not a good specimen of the sponge; but I should like to be assured that Dr. Bowerbank, in preparing his slide, has not somehow mixed up the sponge of the Japanese and Portuguese species together; and I hope that Professor Bocage will give us a figure of the spicules he finds in the Portuguese Sponges. But should it even prove to be correct that the Sponges attached to *Hyalonema mirabile* and *lusitanicum* both belong to the genus *Carteria*, it would be no proof that the coral belongs to the Sponge. Mr. Carter has well observed that, if the polype that forms the bark can secrete the siliceous spicules that occur in the bark, there can be no difficulty in believing that it can secrete the longer spicules that form the rope-like axis.

Even if the Sponge of the two *Hyalonemata* belongs to the same genus, that affords no proof that the glass rope is part of the Sponge. It is remarkable that the *Palythoa*, to which the polypes of *Hyalonema* are most nearly allied, are constantly parasitic on one particular animal; and yet we do not believe that they are part of the animal on which they are parasitic. Some forms of *Palythoa* are only parasitic on some bodies in a peculiar state. The one that Dr. Johnston called *Spongia suberea* (see Mag. Nat. Hist. vii. p. 491, f. 60) is only found growing on shells; but it is never found growing on a living shell, but only on shells inhabited by Bernhard crabs; and somewhat similar species with the same habit are found on the American coast and in other parts of the world; yet no one thinks there is any connexion between the *Palythoa* and the crab or the shell, as Dr. Bowerbank does because the Japanese and Portuguese *Hyalonemata* are sometimes found affixed to a Sponge of the same genus.

Dr. Bowerbank states that he has found in the Portuguese species of *Carteria* all the spicules that are found in the Japanese species, but one. If his observation is accurate, this, to my mind, goes to prove that there are two species of *Carteria* (*C. japonica* and *C. lusitanica*) as well as two species of *Hyalonema*, each having an *Hyalonema* sometimes growing from them, as the species of *Palythoa* on different coasts live on shells inhabited by Bernhard crabs.

I find that I neglected to state that the genus *Carteria* is named in honour of Mr. H. J. Carter, of Budleigh-Salterton, who observed so accurately the structure, habit, and development of the *Spongilla* of Bombay, and has described so well the structure and development of the Foraminifera.

I may also say that the genus *Ingallia* is named in honour

of the late Mr. Ingall, formerly in the Bank of England, an excellent microscopist and collector of sponges, fossils, &c.; *Collingsia* after Mrs. Collings, of Sark, near Guernsey, who has inherited from her father, Dr. Lukis, his love for natural history and the desire to extend it.

During the time this paper has been in type, Dr. Wyville Thomson, in the 'Annals' for February, p. 114, has proposed another arrangement of Sponges. He modestly calls it "a slight modification of Dr. Schmidt's arrangement;" but any reader, even Dr. Schmidt himself, would find it impossible to detect the characters assigned to the families in the very general and indistinct comparative characters assigned by Dr. Schmidt himself to the groups as printed in a previous page of the paper. These characters show the effect of Dr. Bowerbank's researches and figures, and my explanation of them. This arrangement is a step in advance; but it would be better if the step had been made from the examination of specimens instead of from the study of books.

Dr. Oscar Schmidt simply undertook to describe the Sponges of a limited fauna, and only formed an arrangement of them, never intending it for a general system. His work is a very excellent one of its kind, just such a one as we should expect from an experienced and educated naturalist on Sponges, after the publication of Dr. Bowerbank's essay in the 'Philosophical Transactions.'

In consequence of Dr. Wyville Thomson adopting Dr. Schmidt's arrangement, which does not contain several groups of exotic Sponges, he has found it requisite to introduce what he calls a new order. His order VITREA is only a new name given to Dr. Bowerbank's Suborders VI. and VII. (which I had called *Coralliospongiæ*) with the genus *Euplectella* added, but deformed and its character rendered prolix by trying to make it include *Hyalonema*! as his genus *Habrodictyon* is only a name given to my section of the family Euplectelladæ containing the genera *Corbitella* and *Heterotella*.

I have always considered that the characters that Dr. O. Schmidt gives to his families are the weakest part of his work. He perhaps felt that the very limited number of species he had examined did not justify his entering into greater detail. Three of his families were well recognized groups before his time; he added Gumminæ and Halisarcinæ for a few very fleshy Sponges. Dr. W. Thomson observes that "the horn Sponges (*Ceratospongiæ*) and the Gumminæ are so nearly allied that they can be distinguished by comparative characters only." The last group is founded on a mistake, as Dr. Bower-

bank has shown that *Halisarca* contains spicules. If Dr. W. Thomson's arrangement had been founded on the examination of specimens rather than on the characters in books, he would have found that the Gummineæ are allied to Halichondriæ rather than to Ceratospongiæ.

Dr. W. Thomson objects to my separation of the Sponges into Malacosporæ and Chlamydosporæ. The spores of many Sponges are not known, as he observes; but, though we may not know the structure of the spores of many species and genera, we do know that they have not ovisacs or spores like the Geodiadæ and Spongilladæ; for if they had, we should have observed them, as it is almost impossible to examine a fragment of a Sponge of either of those families without seeing them. The skeleton of *Spongilla* is doubtless very like that of *Halichondria*, or rather *Isodictyon*, as Dr. Thomson says after Dr. Bowerbank. The ovisacs of many *Isodictya* are known, and they are all membranaceous.

Both Geodiadæ and Spongilladæ are well defined recognized groups: the latter lives only in fresh water, and is green, all the other Sponges being marine and never green. And Dr. Thomson must regard the solidified ovisac as a good character, or I do not see how otherwise he can arrange the solid calcareous Placospongiæ, which certainly have no bark distinguishable from the axis, such as characterizes his *corticatu*.

I believe the proper way to form a natural system, or one as near nature as we can discover, is to search for some character that is common to a large number of the species, and when one is found, if the group appears a natural one, to use that character for the group, however trivial it may have appeared to our preconceived notions. And this is the course I followed when studying the Sponges; and the result of that study was the belief that the nature of the ovisac does form a character to separate the Sponges into two groups.

The "fatal fascinations of the beauties" do not seem to have come to an end; and I think I may add to the instances recorded by Dr. W. Thomson that he regards "*A. speciosum* as a variety grown under peculiar circumstances, and the short *A. corbicula* with the netted lid as the normal form" of the species. Another is, surely, that Dr. Schultz has proposed to unite *Euplectella* and *Hyalonema* into one family, called Lophospongiæ (see Arch. micr. Anat. iii. 212)! It is astonishing that such an anatomist should regard *Hyalonema* as a Sponge, as it has not one character of the class, except its siliceous spicules; and even if it were a Sponge, no two genera of the same class could be more unlike in structure and form than *Euplectella* and *Hyalonema*.

I cannot understand Dr. W. Thomson's habitat of the two species of Venus's Flower-basket. He says, "The only known specimen of *H. speciosum* is that figured by MM. Quoy & Gaimard in the 'Voyage de l'Astrolabe,' and now in the Jardin des Plantes. The specimen is labelled '*Alcyoncellum corbicula*, Val. Tiré par 80 brasses de profondeur dans la rade de St. Denis de Bourbon par M. Leschenault, 1819.'" If he will turn to MM. Quoy and Gaimard's work, he will find those authors state that their specimen was given to them by Mr. Merkus, the Governor of the Moluccas. The same specimen cannot have two habitats or be collected by two persons at different periods. Does not the label belong to the true *Alcyoncellum corbicula*? The label is of little importance if *Alcyoncellum speciosum* and *A. corbicula* are one species!!

XXV.—On *Autolytus prolifer*. By Dr. R. GREEFF*.

[Plate VIII.]

IN the year 1850, Grube† established, under the name of *Autolytus*, a new genus of Annelids, previously regarded as forming a species of *Syllis*. *Autolytus*, indeed, has characters so definite and so different from those of *Syllis*, as is shown by even a cursory comparison, that this separation must be indicated as not only perfectly just, but actually necessary. For the actual establishment of this idea, however, we are indebted to A. Krohn, who, in his classical memoir "On the Phenomena of Reproduction in *Syllis prolifera* and *Autolytus prolifer*," first distinctly pointed out the distinctive characters of the two genera‡. The interesting processes in the reproduction of *Syllis prolifera* and *Autolytus prolifer* (which, however, as regards the latter, had certainly already been carefully observed by Leuckart and Frey§) are elucidated in this memoir from careful observation, both as regards what they have in common and what is peculiar in each. With regard to *Autolytus prolifer*, Krohn was able to confirm the results already in part obtained by Leuckart and Frey, although those observers still erroneously identified *Autolytus prolifer* with *Syllis prolifera*, and therefore also could not

* Translated by W. S. Dallas, F.L.S., from the 'Archiv für Naturgeschichte,' 1866, pp. 352–367.

† Wiegmann's Archiv, 1850, p. 309, and 'Familien der Anneliden,' 1851, p. 62.

‡ Wiegmann's Archiv, 1852, p. 60.

§ 'Beiträge zur Kenntniss wirbelloser Thiere, &c.,' 1847, p. 91, pl. 2. fig. 1. For the earlier observations of O. F. Müller, Milne-Edwards, Quatrefages, Johnston, &c., consult the authors just cited.

satisfactorily account for the observations previously made by Quatrefages upon the latter*. A further step in the natural history of *Autolytus* was furnished by Max Müller† in his excellent observations on *Sacconereis helgolandica*, although the genetic connexion between *Sacconereis* and *Autolytus* remained unknown to him. It was again Krohn‡ who correctly recognized and established the connexion between these two animals, and showed that the male and female individuals of *Sacconereis helgolandica* observed by Max Müller were merely the freed male and female buds of *Autolytus prolifer*. In the same year (1855), and independently of Max Müller's statements, P. H. Gosse§ also described *Sacconereis*, and indeed its male form, to which that observer gives the new name of *Crithida thalassina*.

For a very detailed memoir, published in the year 1862, upon the natural history and, especially, the sexual relations and development of *Autolytus*, we are indebted to Agassiz||, who, however, on the whole only carried further the notions already expressed by Krohn, especially with regard to the connexion between *Autolytus* and *Sacconereis*, but also proved that the genus *Polybostrichus*, founded in 1843 by Ersted¶, is likewise only a male bud of *Autolytus*, and therefore identical with the male *Sacconereis helgolandica* of M. Müller** and with *Crithida thalassina* of Gosse. Agassiz, moreover, was the first who observed the brood of the sexual buds of *Autolytus* and their development into the primary individuals, and thus filled up what had previously been an important gap. Nevertheless, notwithstanding the great amount of material presented by him, he still remains in many respects behind Krohn as regards the accuracy and clearness of his observations. The generic characters so distinctly pointed out by Krohn for *Autolytus* especially have not been duly noticed by Agassiz: thus, for example, the characteristic elegant circlet of little pointed teeth which crowns the entrance into the tortuous œsophagus is

* Comptes Rendus, August 1843, and Annales des Sci. Nat. 1844, tome i. p. 22. See also the subsequent more detailed treatise upon *Syllis prolifera*, "Mémoire sur la Génération alternante des *Syllis*," in Ann. Sci. Nat. sér. 4. tome ii. p. 143, pl. 4.

† Müller's Archiv, 1855, p. 13, pls. 2 & 3.

‡ Ibid. 1855, p. 480.

§ Ann. & Mag. Nat. Hist. sér. 2. vol. xvi. p. 305, pl. 8. fig. 5.

|| "On Alternate Generation in Annelids, and the Embryology of *Autolytus cornutus*," Boston Journ. Nat. Hist. vol. vii. p. 384, pls. 9, 10, & 11.

¶ Grönland's Annulata Dorsibranchiata, p. 30, pl. 5. fig. 62. Copenhagen, 1843.

** The identity of *Sacconereis* and *Polybostrichus* was indicated in the same year, and apparently before Agassiz, by Keferstein, 'Zeitschr. für wiss. Zool. Bd. xii. p. 113, pl. 11. figs. 1-8.

completely omitted both in the description and in the numerous figures. Claparède, who also notices this defect, in his valuable work on Annelides published in 1864*, has reestablished the genus *Autolytus* as previously indicated by Krohn, and has also enriched our knowledge by three fine new species. Ehlers†, on the contrary, in his work on the Polychæta, has again treated our genus very unkindly, forming a new genus, *Proceræa* (*picta*) of a worm which appears to be undoubtedly an *Autolytus*. That the dorsal cirri on the third body-segment are rather longer than on the following segments (which, moreover, occurs also in other representatives of *Autolytus*—for example, in *A. scapularis*, Clap.) cannot possibly suffice by itself for the establishment of a new genus; and yet this appears to be the only differentiating character, as in other respects, according to the excellent and careful description and figure, *Proceræa picta* in all its essential characters is a true *Autolytus*. Nor must Ehlers's worm be separated from *Autolytus* merely because Ehlers observed no alternation of generations in it. Without taking into consideration that the statements as to the sexual conditions in *Proceræa* are imperfect, even the ascertained absence of alternation of generations, such as Claparède‡ quite correctly establishes for his *A. scapularis*, would by no means of itself justify the establishment of a new genus. I therefore think that I may propose to change *Proceræa picta* provisionally into *Autolytus pictus*.

Under the generic name *Polybostrichus*, Örsted, already referred to, and the connexion of which with *Autolytus* has been described by Agassiz, Keferstein§ has likewise furnished valuable observations on the male bud of *Autolytus*, the identity of which with Max Müller's *Sacconereis helgolandica* he endeavours to demonstrate. It is remarkable, however, that in neither of his memoirs does he say a single syllable of the genetic connexion of *Sacconereis* and *Polybostrichus* with *Autolytus*, so definitely expressed by Agassiz and Krohn, but treats his *Polybostrichus* as a perfectly independent genus.

My own communications are founded upon observations made last year in Heligoland, and partly also during a subsequent residence on the coast of the Channel (chiefly at Ostend). Their principal object is the discussion of three important points in the natural history of *Autolytus*, in the face of the still greatly varying statements, as above indicated, namely:—in the first

* *Glanures zootomiques parmi les Annélides*, p. 102, pl. 7.

† *Die Borstenwürmer*, (Leipzig, 1864) p. 203.

‡ *Loc. cit.* p. 109.

§ *Zeitschr. für wiss. Zool.* Bd. xii. p. 113, pl. 11. figs. 1-6, and p. 464, pl. 42. figs. 5-11.

place, the definitely marked generic character; secondly, the relation of the bud or shoot to its primary individual, together with the connexion of *Sacconereis* and *Polybostrichus* with *Autolytus*; and, thirdly, some remarks upon the species hitherto chiefly investigated, but still very unstable as regards its accurate determination, namely *Autolytus prolifer*, Grube.

As regards the first point, I would, from my observations, sum up the generic character as follows (see Pl. VIII. fig.1):—

Cephalic lobes not separated, but only indicated by an emargination on the lower surface. Three inarticulate frontal tentacles, which, by their lively movements and contractions, present throughout their whole length irregular transverse and annular furrows, so that they appear as if twisted. First body-segment without setigerous feet—but with two tentacular cirri on each side, of the same nature as the cephalic tentacles. On the following segments, on each side, one dorsal cirrus and a uniramous setigerous foot. The composite setæ of the foot (fig.3) have on their short sickle-shaped appendage three uncini—a middle and two lateral ones. Ventral cirri are wanting on all the segments.

The protrusible, finely chitinized cesophageal tube (fig.1a) is surrounded by a muscular sheath, and armed at its anterior orifice with a circlet of small pointed teeth, whilst a large median boring-tooth, otherwise so frequently occurring as the armature of the mouth in the *Syllidea*, is wanting. The cesophageal tube is remarkable for its considerable length, so that only about the anterior half of it follows a straight course, whilst the second half is always folded together in loops. The cesophageal tube is followed by the pharynx or glandular stomach (fig.1b) common to all *Syllidea*. This passes, without any special appendages on its lower part, into the intestinal canal, which runs straight backwards, and is lined in its terminal portion with ciliary epithelium.

In some representatives of *Autolytus* an alternation of generations has been observed, of such a nature that from the primary individuals (= nurses—*Ammen*), by gemmation for the most part, sexual animals are produced and thrown off, which contain either male or female reproductive materials, and after swimming about freely for a certain time, reproduce the form of the parent animal by a sexual process. The budded offspring are not only different from the parent animals, but the males and females differ from each other.

With regard to the second point, I would in the first place once more point out that Krohn was the first who perfectly recognized and declared the genetic connexion between the

free offspring (*Sacconereis* and *Polybostrichus*) and the primary individuals of *Autolytus*. In his first memoir (Wiegmann's Archiv, 1852) he not only correctly described the female *Sacconereis*, but also the male, indicating especially the characteristic and different structure of the tentacles of the male. He says (p. 70), "On the other hand, in the male, the two lateral tentacles are *furcately divided into two diverging branches*, one of which is shorter than the other." In his second communication (Müller's Archiv, 1855, p. 489) he definitely indicates the origin of Max Müller's genus *Sacconereis* from *Autolytus*. I have myself repeatedly observed the whole of the forms just mentioned, and can confirm their mutual relation in the most positive manner, although I have made some divergent observations upon the mode of proliferation. In his description of the structure of the bud-sprouts (*l. c.* p. 74) Krohn says that, with the exception of the first offspring at the hinder extremity of the parent animal, produced at the expense of the hinder part of the body of the mother (as, according to Leuckart and Frey, the buds are produced only between the anterior and posterior sections of the body, *i. e.* push themselves in between these), and which is therefore a true product of fission, ova and semen are not produced in any of the individuals subsequently developed from buds, until at least the head with the traces of the eyes and tentacles has been formed. I have had examples under my eyes in which above the youngest sprout (which therefore hung next to the parent animal) some segments of the primary body already contained ova, although not the smallest trace of head &c. could be detected either upon or above these segments. In a case represented exactly in Pl. VIII. fig. 2, the hinder female sprout was already completely developed, with its head and three tentacles, and had its two following segments stuffed with ova, so that the second body-segment had acquired an unusual degree of extension. *But the last segments of the primary animal impinging on the head of the sprout also already contained ova, although no formation of a head &c. could be detected.* It is therefore evident that the above statement of Krohn's cannot be maintained in its universality. But our observation also imports a not unimportant modification into our notion of the mode of reproduction, as this case proves not only that the fully developed sprouts are capable of producing ova &c., as has hitherto been assumed with regard to *Autolytus*, but that ova may be produced even in the parent body (that is to say, in the *nurse* itself), and, indeed, in segments which still belong to it entirely and unchanged, as has already been ascertained in the case of

Syllis prolifera. Hence, therefore, the *nurse* would at the same time produce asexually by gemmation an offspring destined on its part to generate sexual products, and likewise be capable of giving origin to sexual products (namely, ova) in unaltered segments of its own body. Nevertheless this case, when carefully considered, scarcely presents a serious divergence from the ordinary process of proliferation in *Autolytus* as it has been concordantly described by authors. In this, as has already been remarked, the bud-sprouts are originally produced, not at the end of the parent body, but nearly in its middle, by becoming as it were inserted by gemmation between two segments, and in such a manner that the youngest sprout is always the foremost, and consequently nearest to the anterior part of the primary animal. By this means, therefore, the whole primary individual is divided into two parts, an anterior and a posterior, separated by the intervening sprouts and removed to a greater distance apart in proportion as the number of these increases. But the hinder part of the primary individual is not lost, but becomes formed, like the buds, into a new individual, which is also, like these, destined to generate sexual products. Therefore here also we see sexual products originate in a previously continuous part of the primary individual, in primitive segments of the original nurse, only that this part is no longer in direct connexion with the anterior primary part as was the case in the example above described by me. Nevertheless it cannot be denied that the two cases present a great analogy, inasmuch as, in both, sexual products originate in primitive segments of the original nurse-body.

Through these circumstances, as I would particularly indicate, the mode of reproduction of *Autolytus* (which, as above described, always produces at least one offspring by fission) remarkably approaches that of *Syllis prolifera*, in which, according to the investigations of Krohn* and Quatrefages†, the new individuals originate only by fission. It appears, however, on closer examination, as Ehlers‡ was the first to show, that in *Syllis prolifera* also the increase by fission is only apparently general, but is fundamentally for the most part produced by gemmation as much as in *Autolytus*. Thus it is certain that the segments of the parent animal are made use of for the formation of new individuals; that is to say, those which are by this means thrown off are immediately replaced by gemmation from the primary individual at the point of separation, and this either while the young are still

* Wiegmann's Archiv, 1852, p. 66.

† Loc. cit. *suprà*.

‡ Die Borstenwürmer, p. 208.

connected with the parent, or immediately after their separation. These segments newly formed by gemmation are then, just like their predecessors, developed into a new generation of offspring, and thrown off as apparent products of fission, whilst in reality they only represent newly developed buds. This first gemmiparous proliferation is then again followed at the foremost point of separation by a second gemmation, which, after attaining maturity, probably gives place to a third, and so forth. In *Syllis prolifera*, therefore, only the first generation thrown off consists of true primitive segments of the primary animal, whilst all the following ones undoubtedly originate for the most part from newly developed segments (that is to say, by gemmation). I say, for the most part, as according to Krohn's observations (*loc. cit.* p. 72) it is certainly possible that, in a new budded generation, some segments of the primary animal may again participate in the division and be thrown off with the budded portion, especially if these segments were previously filled with ova &c., and had consequently attained a certain degree of maturity. From these considerations, therefore, it is clear that the processes of proliferation in *Syllis* and *Autolytus*, although apparently so different, scarcely present any essential differences when accurately examined. As we have seen, both in *Autolytus* and *Syllis*, *the first offspring are always pure sprouts of fission, but the following ones originate in both by gemmation.*

Another and different mode of asexual propagation occurs, as is well known, in *Nais*, in which, according to the beautiful and careful investigations of Max Schultze*, a segment of the primary animal is thrown off for each new individual, and employed in the formation of the latter. This segment is not reproduced; so that, during the continuance of proliferation, the parent animal loses as many segments as it throws off young. Max Schultze justly names this process a reproduction by fission, inasmuch as, for every new animal, an original portion of the mother is absorbed. Nevertheless it should not be overlooked that from this single primitive joint the actual many-jointed animal is produced, only by the development or budding forth from it of such a greater or less number of segments as may be necessary for the fully formed animal. In this way, therefore, every new individual thrown off from the primary animal is the product of a pure fission with subsequent pure gemmation; and thus we have here, again, to a certain extent the same point of view for the mode of propagation as in *Syllis* and *Autolytus*, namely the combination of

* Wiegmann's Archiv, 1840, p. 293, and 1852, p. 3.

fission and gemmation, only that in *Nais* these occur very regularly and distinctly in the formation of each new individual.

To return once more to our figured example (Pl. VIII. fig. 2), it is evident that the offspring is still firmly united to its parent, even by the possession of a common intestine, although it is already completely filled with mature ova. This observation, however (as indeed has already been indicated by Krohn), contradicts the assertion of Frey and Leuckart that the new individuals produced by gemmation, so long as they remain inserted in the common stock, do not attain such a degree of development as to render them capable of the production of ova.

Lastly, as regards the third point to be elucidated, namely the establishment of *Autolytus prolifer* as a species, I must admit that I was at first inclined to think that in the animal figured in Pl. VIII. fig. 1 I had a new species before me. This was due in part to the insufficiency of the specific description of *Autolytus prolifer* and the want of accurate figures*. On further comparison, however, I cannot resolve upon the establishment of a new species, but rather believe that my animal coincides with *Autolytus prolifer*. I also think I may say, with probability, that *Autolytus cornutus* of Agassiz is likewise identical with *A. prolifer*; at least, neither from his description nor from his figures (which certainly are not sufficient for specific determination) have I been able to find any essential differences between *A. cornutus*, *A. prolifer*, and my own specimen. What Agassiz says (l. c. p. 391) as to the differences in the number and form of the segments and in the number of the long simple bristles, between the progeny of *Autolytus cornutus* and *prolifer* (*Sacconereis helgolandica*), appears to me to be by no means sufficient for establishing specific distinction between the primary individuals, as, from the above statements with regard to number of segments &c., the prolific progeny not only may, but frequently even must, necessarily, differ from each other in these respects.

It is otherwise with the male progeny of an *Autolytus* known under the name of *Polybostrichus longosetosus*, (Erst., which in all probability represents a species distinct from *A. prolifer*, as the accurate investigations of Keferstein established the existence of essential differences, in the structure of its head &c., from *Polybostrichus Mulleri* (*Sacconereis helgolandica*), the male progeny of *Autolytus*

* Excellent as O. F. Müller's figure of his *Nereis prolifer* (Zool. Dan. fasc. ii. tab. lii. fig. 6) is for that time, it does not suffice for specific determination.

The specific characters* of *Autolytus prolifer* are in many respects difficult to fix; thus, as a matter of course, we must give up even an approximate determination of the length or number of segments of the primary individuals, since these characters, as may be easily seen, vary greatly in consequence of proliferation. The smallest primary individual engaged in proliferation, observed by me, measured 2 millims. to the youngest bud offspring, and contained to the same point fourteen segments, with the exception of the head. The largest primary animal engaged in proliferation, on the other hand, measured more than twice as much as the former, and contained thirty-nine segments to the commencement of the bud offspring. The fully developed animal before the commencement of proliferation must therefore have been a good deal longer. I think, however, that the length of *Autolytus prolifer* will not usually much exceed 2 lines, as stated also by Krohn.

The head presents no indication of lobe-formation on its upper surface; but on the lower surface there is a narrow, median, longitudinal, impressed line, which divides and widens in a curve to right and left posteriorly, and thus forms the anterior buccal angle, so that the hinder parts of the head-lobes at the same time form the anterior buccal lobes or lips. Directly opposite to this anterior buccal angle there is a posterior one, the arms of which join those of the anterior angle, so that by this means a lateral angle is also produced on each side. The buccal orifice has a quadrangular form, bounded by curved lines with their convexity inwards. On its upper surface the head bears four reddish-brown eyes, furnished with lenses, the position of which, however, varies according as the two on each side are more or less approximated to or removed from each other, as shown in our figures. Usually they group themselves in a quadrangle, the anterior pair being further apart than the second (posterior) pair. The three cephalic tentacles occur of very different sizes in different individuals; generally, however, they do not attain the very considerable length represented in fig. 1, but are much shorter. They are then capable of very lively movement, are constantly waved to and fro, and pushed through each other, feeling about, and, when thus employed, show the peculiar transversely furrowed and twisted appearance already

* I shall refer only to the specific characters of the primary individuals of *Autolytus prolifer*, as good and perfectly satisfactory descriptions of the male and female bud offspring (*Sacconereis* and *Polydostrichus*) have been given by the authors already cited, and to these I can add nothing essential.

referred to in the description of the genus. The tentacles, as also the following tentacular and dorsal cirri, are usually greyish yellow, with the exception of the apex, which is sometimes light yellow. The whole of the tentacles and cirri are more or less densely clothed throughout their length with fine soft bristles (tactile hairs), and exhibit in their interior peculiar sharply outlined corpuscles, of a roundish, elongated, or irregular form.

The cephalic segment is followed by the first body-segment, which is very narrow (especially when seen from above) and bears on each side two rather short tentacular cirri, but no setigerous paddles. It is only on the second body-segment, which is considerably broader than the first, that a short uniramous paddle, with two slightly prominent lobes, makes its appearance on each side. In the paddle there is a bundle of from eight to ten closely approximated strong and short setæ. Two of the setæ (and these are the strongest and usually placed rather behind the rest) are simple, the others are composite. The simple setæ have exactly the form of the composite ones, except that in the former the sickle-shaped terminal joint is wanting, and the otherwise short apical portion is somewhat elongated, especially on the hinder segments. The composite setæ bear the short tridentate terminal joint already described in the generic character (fig. 3). Above the paddles of the second segment there is on each side a long dorsal cirrus resembling the cephalic tentacles. The dorsal cirri of the following segments are considerably shorter. All the dorsal cirri consist of two joints—a short, conical, tuberculiform basal, and a thinner terminal joint. In all the cirri the basal joint shows a lively ciliary movement, but this never extends over the terminal joint. Ventral cirri are deficient on all the segments. The caudal cirri are usually long, and furnished with many tactile hairs.

With regard to the characteristic alimentary apparatus, especially the œsophageal tube, I may refer in general to the description already given under the generic character, and to the figure (fig. 1, *a*, *b*, *c*). Usually the œsophagus commences in *Autolytus prolifer* within or below the second setigerous-segment. The glandular stomach commences at the eighth or ninth, and generally includes two or three segments in its length. The intestine is broad, and presents no constrictions corresponding with the individual segments; but at every two, three, or four segments there is a constriction, which, however, does not penetrate deeply. The head and body present a yellowish-brown coloration, sprinkled with dark-reddish-brown irregular small granules, spots, and streaks. Frequently also

a reddish-brown longitudinal streak is seen on each side, commencing at the head and running along the back; but these usually reach only to the glandular stomach.

In conclusion, I may cite an observation upon the occurrence of the freed, sexually mature bud offspring (*Sacconereis* and *Polybostrichus*), which I do not find mentioned anywhere else. These bustle about exactly in the manner of the swarming Annelide-larvæ, and, indeed, among the latter at the surface of the sea; so that, in nearly every glass filled with the small animal forms fished from the surface of the calm sea by means of the fine net, I regularly found several of them, and usually male examples. These possessed great mobility. Primary individuals I have never found at the surface; and the reason of this is easily understood.

EXPLANATION OF PLATE VIII.

Fig. 1. Anterior part of *Autolytus prolifer*, with the head, the first body-segments, and the principal sections of the alimentary apparatus: *a*, oesophageal tube, with its cirlet of pointed denticles at its anterior orifice, and its posterior half bent into loops; *b*, glandular stomach; *c*, intestine.

Fig. 2. The posterior segments of the primary animal, containing ova, with a young animal adhering to them, still united with them by a common intestine, and completely filled with ova: *d*, the new-formed head of the young animal, with the new-formed eyes and tentacles.

Fig. 3. Composite uncini of *Autolytus prolifer*.

XXVI.—*Notulæ Lichenologicæ.* No. XXI.

By the Rev. W. A. LEIGHTON, B.A., F.L.S.

AMONGST the MSS. of the late Rev. Edw. Williams, Incumbent of Battlefield and Uffington, Shropshire, is a catalogue of all the plants which he had detected during many years' careful herborization of the county of Salop. Mr. Williams was in frequent correspondence with Sir J. E. Smith, the Sowerbys, and other contemporary botanists. His accuracy is well known, and perfect reliance can be placed on any plant which he recorded. The whole of the Catalogue, so far as regards the flowering plants, is embodied in my 'Flora of Shropshire.' But I have thought it might not be altogether unacceptable to publish the list of Shropshire Lichens. Though not a complete list, it is a fairly comprehensive one, considering that at the period of its compilation the microscope was not used in the determination of these plants.

To this list I have added between brackets [] brief remarks

identifying the lichens according to more modern nomenclature.

LICHENES.

Lichen alpestris [*Cladina alpestris* (*Schær.*)]. Bomere Moss, Stiperstones, &c.

Lichen antiquitatis [probably a *Byssus*]. Cound churchyard-wall.

Lichen apthosus [*Peltigera apthosa*, *Hoffm.*]. Side of walk in Sundorn Wood; wall of Acton Burnell Park.

Lichen aquilus [*Physcia aquila*, *Fr.*]. (See *pullus*.)

Lichen ater [*Lecanora atra*, *Ach.*]. Branches of trees and walls.

Lichen atro-albus [*Lecidea atro-alba*, *Flot.*]. Rocks.

Lichen aurantiacus [*Lecanora aurantiaca*, *Lightf.*]. Trunks of trees.

Lichen byssoides [*Bæomyces rufus*, *Ach.*]. Stone-quarry on Cound Moor; rocks about Bishop's Castle (*Dillenius*).

Lichen brunneus. [Without examination of specimens it is impossible to say whether this is *Lich. brunneus*, *E. Bot. t. 1246* = *Parmelia triptophylla*, *Fries*, or *Lich. brunneus*, *Swartz* = *Parmelia brunnea*, *Fries*, the habitat being similar in both.] On stones on Cound Moor, on the bank sloping down to the brook below a cottage belonging to the clerk (*Dr. J. E. Smith*).

Lichen Bæomyces [*Bæomyces roseus*, *Pers.*]. About Ludlow.

Lichen cyclosetis [a state of *Physcia obscura*, *Fr.*, *E. Bot. 1942*]. Trunks of oak and ash trees (*Dr. J. E. Smith*).

Lichen calicaris [*Ramalina calicaris*, *Fr.*]. Branches and trunks of trees.

Lichen candelarius [*E. Bot. 1794*]. Walls.

Lichen canescens [*Lecidea canescens*, *Ach.*]. Walls and trunks of trees.

Lichen caninus [*Peltigera canina*, *Hffm.*]. Dry ditch-banks; common.

Lichen carpineus [possibly a state of *Pertusaria communis*, *DC.*]. Trunks of trees.

Lichen confluens [most probably *Lecidea contigua*, *Fr.*]. Loose stones below Pontesford Hill.

Lichen caperatus [*Parmelia caperata*, *Ach.*]. Rocks and trunks of trees on Haughmond Hill, &c.

Lichen cartilagineus [*Squamaria crassa*, *DC.*]. Rock on Overley Hill; on Wrekin, and on Abury Wood.

Lichen cerinus [*Lecanora cerina*, *Ach.*]. Trees in Vesson's Wood, under Stiperstones.

Lichen chalybeiformis [a form of *Alectoria jubata* (*Linn.*)]. On Stiperstones (see *Dillenius*, p. 67, tab. 13. f. 10).

Lichen ciliaris [*Physcia ciliaris*, *DC.*]. Trunks of trees.

Lichen cocciferus [*Cladonia cornucopioides*, *Fr.*]. Rocks on Overley Hill; Frodesley Hill, &c.

- Lichen coccineus* [*Lecanora hæmatomma*, *Ach.*]. Rocks on Haughmond Hill; Pontesford Hill; Frodesley; Acton Burnell, walls; Titterstone Clee.
- Lichen concentricus* [*Lecidea petræa*, var. *concentrica* (*Dav.*), *E. Bot.* 246]. First canal-bridge between Uffington and Atcham.
- Lichen corallinus* [*Stereocaulon corallinum*, *Schreb.*]. Rocks and walls; Frodesley; Stiperstones; north side of a hill between the Wrekin and the Arcoll Hill; Acton Burnell.
- Lichen crispus* [*Collema crispum*, *Ach.*]. Bottom of shady walls.
- Lichen cristatus* [*Collema cristatum*, *Schær.*]. Bottom of shady walls.
- Lichen ericetorum* [*Bæomyces icmadophilus*, *Ehrh.*]. Sides of banks about Ludlow.
- Lichen excavatus* [*Urccolaria scruposa*, *Ach.*]. Walls of Col. Charlton's park, Ludlow.
- Lichen fagineus* [probably *Variolaria faginea*, *Pers.*, a sorediate state of *Pertusaria communis*, *DC.*]. Trunks of trees, common.
- Lichen farinaceus* [*Ramalina calicaris*, *Fr.*, var. *farinacea*, *Ach.*]. Trunks of trees.
- Lichen fascicularis* [without examination of specimens it is difficult to say to what species of *Collema* this should be referred]. Trunks of trees in a wood on the north-east side of the Stiperstones.
- Lichen ferrugineus* [*Lecanora ferruginea* (*Huds.*)]. Parapet-wall of Cound Stank bridge.
- Lichen flavescens* [probably comprehending *Placodium murorum*, *DC.* and its var. *citrinum* (*Hffm.*), and *Placodium olegans*, *DC.*, and *Lecanora aurantiaca* (*Lightf.*), var. *erythrella* (*Ach.*)]. Walls and rocks.
- Lichen floridus* [*Usnea florida*, *Linn.*]. Trunks of trees in wood below the Stiperstones and near Ludlow.
- Lichen foliaceus* [*Cladonia alpicornis*, *Flk.*]. Rocks on Haughmond Hill; Lyth Hill; Pontesford Hill.
- Lichen fraxineus* [*Ramalina calicaris*, *Fr.*, var. *fraxinea*, *Fr.*]. Trunks of trees; common.
- Lichen furcatus* [probably *Cladonia furcata*, *Schær.*, including *pungens* (*Ach.*), not at that time separated]. Rocks and heaths.
- Lichen furfuraceus* [*Evernia furfuracea*, *Mann.*]. Rocks on the Stiperstones; Frodesley Park-wall; rocks north side of Wrekin.
- Lichen fusco-ater* [*Lecidea fusco-atra*, *Ach.*]. Walls; by side of turnpike road near Cound Hall (wall taken down).
- Lichen geographicus* [*Lecidea geographica*, *Schær.*]. Rocks.
- Lichen glaucus* [*Platysma glaucum*, *Hffm.*]. Frodesley Park-wall; Wrekin; Stiperstones; Caradoc Hill.
- Lichen globiferus* [*Sphærophoron coralloides*, *Pers.*]. Rocks on Haughmond Hill; Frodesley Hill; Stiperstones; Caradoc.
- Lichen glomuliferus* [*Ricasolia glomulifera*, *De N.*]. Trunks of trees between Castle Pulverbach and Stiperstones.

- Lichen gracilis* [Cladonia gracilis, *Fr.*]. Stiperstones Heath.
- Lichen hymeneus* [Pertusaria Wulfenii, *DC.*]. Trunks of trees (Dr. J. E. Smith).
- Lichen inquinans* [Trachylia tympanella, *Fr.*]. Old pales.
- Lichen inclusus* [Thelotrema lepadinum, *Ach.*]. Holly trees on Acton Burnell Hill.
- Lichen linceus* [Opegrapha lyncea, *Borr.*]. Trunks of trees.
- Lichen herbaceus* [Ricasolia herbacea, *D. N.*]. (See *latevirens.*)
- Lichen hirtus* [Usnea barbata, *Fr.*, *forma hirta*]. Trunks of trees.
- Lichen hispidus* [Cetraria aculeata, *Fr.*]. Walls on Frodesley Hill ; rock on Overley Hill ; Wrekin ; Stiperstones ; Caradoc ; Brown Clee.
- Lichen horizontalis* [Peltigera horizontalis, *Hffm.*]. East wall of Frodesley Hill and Acton Burnell Hill.
- Lichen hypnorum* [E. Bot. 740]. Whitecliff, near Ludlow.
- Lichen jubatus* [Alectoria jubata, *Ach.*]. Wall of Frodesley Park ; Upton Park pales ; Pimhill Rocks ; Caradoc ; Stiperstones.
- Lichen latevirens* [Ricasolia herbacea, *De N.*]. On stones at Comb Floyd, near Bishop's Castle (Dillenius).
- Lichen luteus* (*luteo-albus*) [Lecanora cerina, var. *pyracea*, *Ach.*]. Trunks of trees.
- Lichen niger* [Pannaria corallinoides, *Schær.*]. On Cound churchyard-wall.
- Lichen nigrescens* [Collema nigrescens, *Ach.*]. Old ash trees near Radnor Bridge ; crab-trees on Pontesford Hill and about Pulverbach.
- Lichen Æderi* [this, in all probability, comprehends many things, as *Lecidea petraea*, var. *Æderi* (*E. Bot.* 1117), *Lecidea melanophæa*, *Fr.*, and forms of *Urceolaria*, &c.]. Stiperstones.
- Lichen olivaceus* [Parmelia olivacea, *Ach.*]. Trunks of trees ; common.
- Lichen omphalodes* [Parmelia saxatilis, *Ach.*, var. *omphalodes*, *Ach.*]. Rocks on Haughmond Hill.
- Lichen pallescens* [Lecanora parella, *Ach.*, var. *pallescons*, *Ach.*]. On trunks of trees.
- Lichen parilis* [Nephroma lævigatum, *Ach.*, var. *parile*, *Ach.*]. In an old stone-quarry on Cound Moor.
- Lichen parellus* [Lecanora parella, *Ach.*]. Trunks of trees.
- Lichen parietinus* [Physcia parietina (*Linn.*)]. Walls and trunks of trees.
- Lichen perlatus* [Parmelia perlata, *Ach.*]. Trunks of trees ; common.
- Lichen pertusus* [Pertusaria communis, *DC.*]. Bark of trees and walls.
- Lichen physodes* [Parmelia physodes, *Ach.*]. Old pales ; common.
- Lichen polyrrhizus* [Umbilicaria polyrrhiza (*Linn.*)]. Stiperstones.
- Lichen prunastri* [Evernia prunastri, *Ach.*]. Branches of bushes and trees ; common.

- Lichen pulicaris* [probably *Opegrapha varia* f. *pulicaris* (*Hffm.*), including also possibly *Hysterium pulicare*, a fungus]. Trees.
- Lichen pullus* [*Physcia aquila*, *Fr.* (*aquilus*, *E. Bot.* 982)]. Rocks on Haughmond Hill.
- Lichen pulmonarius* [*Sticta pulmonacea*, *Ach.*]. Trees at the back of Acton Burnell Hill and below Stiperstones and Frodesley Hill.
- Lichen punctatus* [*E. Bot.* t. 450 : a saxicolous form of *Lecanora subfusca*, *Ach.*]. Cound churchyard-wall ; Ludlow.
- Lichen pyxidatus* [*Cladonia pyxidata*, *Hffm.*]. Dry ditch-banks ; common.
- Lichen querceus* [*Lecidea quercea*, *Ach.*]. Trunks of oak trees.
- Lichen rangiferinus* [*Cladina rangiferina* (*Hffm.*) and *sylvatica* (*Linn.*)]. Dry heaths ; common.
- Lichen rugosus* [according to Fries, *Lich. Europ.*, a fungus, *Hysterium rugosum*, *Dill. Musc.* xviii. f. 2]. Trunks of trees.
- Lichen salicinus*. (*See aurantiacus.*)
- Lichen sanguinarius* [*Lecidea sanguinaria*, *Ach.*]. Trunks of trees.
- Lichen saxatilis* [*Parmelia saxatilis*, *Ach.*]. Stones, walls, trunks of trees, and tiles.
- Lichen scriptus* [including most probably all the *Graphidei*]. Trunks of trees.
- Lichen scrobiculatus* [*Sticta scrobiculata*, *Ach.*]. Stones on Frodesley Hill ; Stiperstones ; Caradoc.
- Lichen scruposus* [*Urceolaria scruposa*, *Ach.*]. Cound churchyard-wall ; Acton Burnell Park-wall ; walls on Harmer Hill.
- Lichen sinuatus* [possibly *Leptogium scotinum*, *Fr.*]. Rocks about Ludlow.
- Lichen spinosus* [probably *Cladonia furcata*, var. *spinosa*, *Flk.*, *Dill.* xvi. f. 25]. Stiperstones rocks.
- Lichen sphaerocephalus* [*Calicium sphaerocephalum*, *Ach.*]. Trunks of trees ; common.
- Lichen stellaris* [*Physcia stellaris*, *Fr.*]. Trunks of trees.
- Lichen subfuscus* [*Lecanora subfusca*, *Ach.*, and its innumerable forms]. Trunks of trees.
- Lichen subulatus* [probably some state of *Cladonia furcata*, *Schær.*]. Heaths and rocks.
- Lichen sulphureus* [*Lecidea sulphurea*, *Ach.*]. Stone wall by side of the road over Haughmond Hill ; Cound churchyard-wall.
- Lichen tartareus* [*Lecanora tartarea*, *Ach.*]. Rocks at the top of the Stiperstones ; Overley Hill ; Caradoc and Frodesley Hills.
- Lichen tremella* [possibly *Leptogium lacerum*, *Fr.*]. Cound churchyard-wall.
- Lichen tremelloides* [possibly *Leptogium tremelloides*, *Fr.*]. Springs under the Wrekin ; stumps of trees and stones on Acton Burnell Hill.
- Lichen Turneri* [*Lecanora tartarea*, var. *Turneri* (*Sm.*) *E. Bot.* 857]. Trunks of old ash trees &c.

Lichen uncialis [Cladonia uncialis, Hffm.]. Rocks and heaths.

Lichen varius [Lecanora varia, Ach.]. Old pales.

Lichen venosus [Peltigera venosa, Hffm.]. Near Ludlow (Dr. Babington).

Lichen vernalis [Lecidea vernalis, Ach.]. Walls.

Lichen vespertilio [Collema nigrescens, Ach.]. (See *nigrescens*.)

XXVII.—On the Spongiæ ciliatæ as Infusoria flagellata; or Observations on the Structure, Animality, and Relationship of *Leucosolenia botryoides*, Bowerbank. By H. JAMES-CLARK, A.B., B.S., Professor of Natural History in the Agricultural College of Pennsylvania.

[Continued from p. 142.]

§ 4. *Bicosæca lacustris*, n. sp. Pl. V. figs. 33, 33^a, 33^b, 33^c.

This species lives in quiet streams and lakes, attached to filamentous Algæ, and is quite common, especially on old specimens of *Zygnema*. It is tinged throughout with a yellowish colour, which seems to add a good deal to the difficulty of distinguishing its various parts. When protruded (fig. 33), it occupies the anterior half of the calyx (*c*) and projects a little beyond its edge, and consequently its retractor ligament (*r*) stretches over the whole posterior half of the dormitory. The shape is rather elliptical than elongate-oval; but it varies more or less between these two forms, and seems to have the latter shape in the largest individuals. Posteriorly the body is rounded; but its broadest region is about the middle, and from thence it tapers considerably to a truncate front, and ends on one side in a laterally projecting *flagellum* (*f*), and on the opposite side in a long incurved *lip* (*lp*).

The longitudinal furrow (*r*¹), which is so conspicuous in *B. gracilipes*, is much narrower in this species, and not so deep; yet it holds exactly the same relations to the base of the flagellum (*f*) and the contractile ligament (*r*). After a number of observations upon the frequent and sudden retraction of the body to the bottom of its calyx, during which in every instance that side along which the furrow (fig. 33^c, *r*¹) runs was contracted much more than the opposite one, I feel quite confident that this sulcus is the seat of a highly contractile band, and moreover that it is continuous with the posterior retractor ligament (*r*). The latter is very slender and thread-like, and is attached to the posterior end of the body on one side (see fig. 33^a, *r*) of its axial line, and has very much the appearance of being a free continuation of a ligament in the furrow just

mentioned. The *lip* is nearly twice as long in proportion to the breadth of the front as that of *B. gracilipes*, and has an incurved digitate form (figs. 33, 33^a, *lp*).

The *flagellum* (*fl*) is the most remarkable and distinguishing feature of this species, when contrasted with *B. gracilipes*, on account of the wide angle at which it diverges from the longitudinal axis of the body; for whilst in the latter it deviates but little from parallelism with the axial line, in the former it arises at an angle of from forty to forty-five degrees (fig. 33^a, *fl*) with the same line. At its base it curves away from the lip, but for the remaining four-fifths it bends with a long arch in the opposite direction, but not so much as to bring its tip in a line with the body. It is therefore altogether eccentric; but yet its curve lies in the same plane relatively to the mouth and lip as that of its marine congener. Its length is about two and a half times that of the body; and it scarcely, if at all, tapers from one end to the other. It usually is held in a rigid attitude, except at the tip, which is always kept in a rapidly gyrating state, accompanied frequently by spasmodic incurvatures, when floating particles are thrown by it towards the mouth (*m*). Its flexibility is exhibited during the frequent spasmodic retrocessions of the body (fig. 33^e), in the same way as in the other species; and the like remark applies to its action when assisting the lip to force the food into the mouth.

The *mouth* (*m*) opens in a slight hollow which lies between the base of the flagellum on one side and the lip on the other, and therefore is concentric with the longitudinal axis of the body. It very readily takes in quite large particles (fig. 33, *m*) of food, with the aid of the incurvating lip (*lp*) and the flagellum (*fl*), and immediately encloses them in a digestive vacuole, or, more properly speaking, a hyaline envelope, within which they revolve for a while with considerable rapidity. The *anus* (fig. 33, *a*) lies in the same hollow as the mouth, but further up on the base of the lip. That it is distinct from the mouth was frequently demonstrated by the collection of large globular masses in the base of the lip, and sometimes further up, and their subsequent exit thereabouts.

The *two contractile vesicles* (*cv*, *cv*) form another very strong mark of distinction, since they are not only double the number of that of *B. gracilipes*, but are also situated at the extreme posterior end of the body. They are quite conspicuous, and appear to lie right and left of the plane which passes through the lip, flagellum, and furrow. The systole of each alternates with that of the other, and occurs from five to six times in a

minute, but with nothing remarkable in its action, unless it be that it operates more moderately than in *Monas*.

The calyx (*c*) has, in its fully developed condition, about the same shape and proportions as that of the marine form (figs. 34, 35), but, like the body, it is much larger. In its younger stages (figs. 33^a, 33^b, 33^c, *c*, *c*¹) its aperture (*c*¹) almost closes when the body is retracted (fig. 33^c), and during the protrusion of the latter its rim (fig. 33^a, *c*¹) embraces it very closely, so that on the whole the calycle has an elongate-ovate shape, with a narrowed, truncate, smooth margin. During the undeveloped stages of the calyx, the pedicel (*pd*) is less than half its length, and from that it varies down to little (figs. 33^a, 33^c, *pd*) or nothing; but when the former is full-grown (fig. 33, *c*) the latter (*pd*) is at least half as long as it. It is more slender than that of *B. gracilipes*, and, like the latter, is attached to the base of the calyx opposite to the insertion of the retractor ligament (*r*).

§ 5. CODONÆCA, nov. gen.*

Codonæca costata, nov. sp. Pl. V. fig. 36.

Of all the calyculate Flagellata, the species before us is perhaps by far the most beautiful, both in physiognomy and proportions. It is a marine form, and was found with *Bicosæca gracilipes*. Generically it differs from *Bicosæca* (§§ 3 & 4) in having neither a basal retractor muscle, nor lip, nor lateral longitudinal furrow, and by the attachment of its single flagellum (*f*) to the central point of the front. From *Salpingœca* (§§ 7, 8, & 9) it differs principally in not possessing a projecting collar or rim about the anterior end; but, as in that genus, the body is not attached to the calyx by any visible means. It cannot be a *Dinobryon*, since that, as Claparède has already shown, has but a single contractile vesicle, and, moreover, it is situated near the anterior end of the body, and just behind a red eye-spot. *Dinobryon* has a slightly notched asymmetrical front; in fact it is a calyculated Euglenian. The general tint of the body of *Codonæca costata* is a dingy yellow, whilst the calyx (*c*) is colourless and excessively transparent. The shape of the body is oblong, rounded posteriorly, and slightly pointed in front, where the flagellum (*f*) is attached. Its posterior half nearly fills the basal third (*c*²) of the calyx.

The flagellum (*f*) has not that rigid carriage which is so characteristic of that of *Bicosæca* (§§ 3 & 4) and *Anthophysa* (§ 11), but is a truly vibratile organ. It is kept in an almost constant state of rapid agitation, and projects at the same time far beyond the rim (*c*¹) of the calyx. It is by no means easy

* κώδων, a bell; οἰκίζω, to inhabit.

to detect, even with a power of eight hundred diameters, not only because it is seldom at rest, but on account of its excessive delicacy; yet when it does stop its vibrations, its character and proportions can be unequivocally demonstrated under the proper circumstances of illumination and adjustment. It is about twice as long as the body, and has a decided although not rapid taper at its distal termination.

The *mouth* remains yet to be discovered. There can be no doubt, however, that it is an aperture of no very small extent, or at least that it is capable of considerable distention, inasmuch as we find quite large angular particles within the body. That it is terminal rather than lateral, is probable from the similar position of this organ in the not very distantly allied genus *Codosiga* (§ 6).

The two *contractile vesicles* (*cv*, *cv*) are situated midway between the front and hind ends of the body, and at two nearly opposite points. They are of moderate size, yet not so large as those of *Codosiga* (§ 6), which they resemble, but exhibit a much feebler action than the latter.

The *calyx* (*c*¹ *c*²), or carapace so called, has an ovate-campanulate outline, but is divided by a constriction into two regions. One of these, the basal (*c*²) or posterior third, is about one-half as wide as the remaining two-thirds (*c*), and possesses an ovate-obconical form, which tapers abruptly into the pedicel (*pd*). The anterior two-thirds (*c*) arises from the sharp constriction with a strong swell or bulging, and then, narrowing a little, terminates with a truncate aperture (*c*¹); so that on the whole this portion may be compared, in shape and proportions, to a claret-glass. This region is peculiar, moreover, in being longitudinally banded or sulcated by about twenty furrows, which terminate at the rim in as many notches, that alternate with a like number of distinct scallops. Of these two regions, the basal one is quite distinct, although perfectly hyaline; but the banded part is much fainter, and requires a careful adjustment of the light in order to bring it out clearly. The *pedicel* (*pd*) is moderately slender, colourless, at least as long as the *calyx*, and of a uniform thickness from base to top.

§ 6. CODOSIGA, nov. gen.*

Codosiga pulcherrima, nov. sp. Pl. V. figs. 7-27.

This infusorian is as eminently a compound Flagellifer as *Anthophysa* (§ 11), and, although not a heteronematous form (like the latter), it bears a very striking general resemblance to it, as one may see by comparing figs. 8 and 47 with each other.

* κώδωρ, a bell; σιγῶν, to be silent.

It also frequents the same habitat as *Anthophysa*, where it is quite abundant, and readily recognized, when one has become familiar with it, even under as low a magnifying-power as two hundred diameters. The greater number of individuals are found attached singly (figs. 9 and 24^a) or in twos to a slender peduncle (*pd*); but often three or four constitute a colony. A group of these monads seated on their short pedicels (fig. 8, *pd*²), and the latter arising from a nearly common point at the end of a long slender peduncle (fig. 8, *pd*), might be designated, in botanical parlance, as umbellate. Very seldom are more than four or five bodies assembled in one colony; but occasionally as many as eight (fig. 7) are united in a single umbel. They bear the same remarkable relation to each other and to the main stem (*pd*) that we find in *Anthophysa*: that is to say, the arcuate flagellum (*f*) of every member of the group curves backwards towards the base of the common peduncle (*pd*); and consequently the rest of the organism of each one holds a corresponding position. When there are but three or four in a colony, the longer axis of each monad usually diverges at an angle of not more than thirty or thirty-five degrees from the axis of the main stem; but when the number is greater, the divergence is also greater, and frequently amounts to seventy or eighty degrees. Oftentimes it will be observed that several of a group of bodies are attached in pairs (figs. 21, 22) to the pedicels, instead of each being possessed of a support of its own. This, as will be explained more fully under the head of *fissigemmation*, arises from an incompleteness of the self-division of which the pairs are the several resultants; and it will be noticed also that they are smaller than those which arise singly from the common peduncle.

The usual *form* of the body is an oblique oval (figs. 25, 26, 27), which is twice as long as it is broad; but in old individuals which are about to undergo self-division, the shape is very broadly oval (fig. 24^a), and its one-sidedness is not very conspicuous. The same may be said of specimens which have lived for a while in stale water, and have lost nearly all their yellow colour (fig. 24). Posteriorly it tapers, more or less abruptly, into the pedicel (figs. 25, 26, 27, *pd*³); but anteriorly it is slightly constricted (*b*²) a short distance behind the front, and thence projects in the form of a low truncate cone (fig. 24^a, *fr*). From the constriction (*b*²) there projects, in direct continuation of the epidermis of the body proper, a very high, membranous, campanuliform collar (*b* *b*¹), presenting on the whole an appearance as if the body were seated in the lower half of a deep urceolate calyx. That this collar is not the upper portion of an urceolus, in any sense of the term, may be

demonstrated in two ways at least. In the first place, it is highly flexible and retractile, as it occasionally shows itself to be, either by narrowing its aperture almost to absolute closure (fig. 24, *b*), or by reducing its height to a small fraction of its greatest altitude (as seen in fig. 27, *b*); and then extending itself again, within a few seconds, by a direct protrusion (fig. 26, *b*), to its original proportions (fig. 25, *b*). In the second place, it divides longitudinally, like the rest of the body, when self-division occurs (figs. 11–22)—a process in which no genuine calycle was ever known to be concerned. In an adult state (figs. 8, 11, 24^a, 25) it is slightly constricted by a gradual incurvature extending from the base (fig. 24^a, *b*²) to the distal margin (*b*¹); but frequently, and apparently always just before self-division takes place, its sides bulge slightly outward (fig. 11, *b*). Taking all these things into consideration, therefore, it is perfectly clear that this infusorian is not a calyculate form, but one of those mimetic shapes which occasionally deceive the eye and puzzle the observer, until he becomes familiar with their various phases of growth and development.

This phenomenon is most singularly exemplified by the creature before us now, in its almost indistinguishable resemblance to a genuine calyculate Flagellifer (*Salpingoeca marina*, Pl. VI. figs. 28–32^a) which abounds in our marine waters. This similarity arises chiefly from the fact that the urceolus (figs. 28–32, *c*) of the latter has an oval shape like the body of the former, and is constricted so closely at its aperture (*c*¹) as to present the appearance of being continuous with the high campanuliform collar (*b*) which projects from the front. Usually, however, the body proper of this animal (*Salpingoeca marina*, nov. sp.) lies loosely within, and considerably withdrawn (fig. 28) from, the parietes of its calyx; but occasionally in older specimens it completely fills (fig. 31) its sheath; and then it is next to impossible to distinguish it, in this respect, from a *Codosiga*. In a sessile freshwater species of *Salpingoeca* of the urceolate type (*S. amphoridium*, figs. 37–37^a), the resemblance to *Codosiga* is almost as strong, but the difference is equally marked.

The *flagellum* (figs. 8 &c., *f*) is the only prehensile organ which *Codosiga* possesses. It arises from the middle of the low truncate cone (*f*^r) which constitutes the front, and consequently within the campanulate collar (*b*), reminding one of the curvate *style* of a labiate monopetalous flower. It is usually rigid, excepting at the tip, which is constantly occupied in throwing particles of various kinds toward the mouth (*m*) by vigorous spasmodic incurvations or jerks. At its basal half it is slightly curved towards the longer side of the body, but

gradually reverses the arc and, assuming a much stronger bend in the opposite direction, terminates abruptly, and far beyond the edge (b^1) of the collar, with about the same thickness as at its base. It is a very conspicuous organ, and therefore its whole sigmoid length may be studied with any amount of detail that could be wished for. The plane of this sigmoid curve is a direct continuation of that which passes through the opposing longer and shorter curves of the obliquely oval body. Calling to mind now what has been said in regard to the direction of the curve of the flagellum of the respective individuals of the colony, it will be seen that if these planes are projected inwardly and downwardly, at the same time passing along the pedicels (fig. 8, pd^s) of each body, they will all meet at the main stem (pd).

Besides being used as an organ of prehension, the *flagellum* is occasionally devoted to other purposes,—for instance, to act as a scavenger by whirling in a gyratory manner, and thus clearing the area within the collar of faecal matters which have been ejected from the anus at a point near to, or perhaps coincident with, the mouth (m). At other times it acts as an organ of propulsion during the act of natation (fig. 23), when one of the resultants of self-division breaks loose from the colony and seeks another point to settle down upon and secrete its stem. During this wandering life of the Monad it swims, at times very rapidly, with its basal end (fig. 23) preceding it in the direction of its course, and the *flagellum* (f) following behind and vibrating in rapid undulatory and gyratory curves, as if it were the screw propeller of some subaqueous vessel.

That the *mouth* (figs. 23, 24, 24^a, m) is situated near the base of the flagellum (f) is rendered certain by the fact that particles of food are thrown by that organ directly against the area (fr) upon which it is based, and are taken within the body somewhere in that region; but, on account of the minute size of these morsels, and the rapidity with which they are swallowed, it has not been possible to determine precisely at what point. The position of the *anus*, which, as I have already suggested, may possibly be coincident with the mouth, is easily determined, even to the narrowest limits, as the faecal matter is discharged in large, highly refractile pellets (fig. 24^a, d) close to the base of the flagellum. The digestive vacuoles are quite conspicuous, and frequently very large; but they never have been observed to be so numerous as to obscure the view of the interior of the body.

The *contractile vesicles* (cv , cv) are two quite conspicuous globular organs, which lie close to the surface and in the posterior third of opposite sides of the body. Occasionally three

(fig. 10, *cv*) of these vesicles are found together; but it has always been evident at such a time that the body was preparing for fission (figs. 9, 10), and that the increase in number of these organs arose from the fact that one of them had already undergone self-division. In another genus (*Salpingoeca*, *S. marina*, nov. sp., figs. 28, 29, 30) no less than *four* contractile vesicles (*cv*) have been observed to arise from two, under the same circumstances.

The systole of each vesicle of *Codosiga* occurs regularly once in half a minute, and usually that of one alternating with that of the other. Both the systole and the diastole proceed very deliberately, each, however, not occupying more than a few seconds. During the interval between the end of the diastole and the beginning of the systole the vesicles have a rather irregular, indefinite, spheroidal outline; but just at the moment of systole they assume a sharply defined and perfectly globular shape, and raise the surface of the body into a quite perceptible bulge. During this momentary expansion a vesicle equals at least half the greatest diameter of the body.

The *reproductive organ*, if we are not mistaken in our interpretation, is seated at the posterior end of the body, behind the contractile vesicles. It is a globular, highly transparent body (figs. 23, 24, *n*), and sometimes almost fills the space on each side of it. That it is solid, and not a mere vacuole, appears conclusive from its resilient action after being indented by the expansion of the contractile vesicles. It should be mentioned that this body was not observed in the fresh specimens which were collected in December, but appeared to be constant in some stale examples which had been kept on hand for two or three months.

The *peduncle* (fig. 8, *pd*), or main support of the colony, and the pedicels (*pd'*) or immediate bearers of the individuals, share in the general gamboge-yellow colour of the latter, and also in their vitality. The latter statement has been verified fully in regard to the pedicels, by seeing them split down to their bases after the body proper has undergone self-division; and in regard to the peduncle, although only one observation was made, and the splitting was followed in its slow course downward for only a short distance, it was evident, from its much more than usual thickness and the presence of a distinct median furrow which extended to its very base, that it eventually would divide into two stems. The length of the peduncle varies from a mere disk, when it begins to develop from the base of some newly settled Monad, to five or six times the length of an individual. It always carries a single body until it is at least three or four times its length (figs. 9,

24, 24^a), and frequently much longer; but in the latter case it was sometimes observed to arise from the falling away of one of the resultants immediately after self-division occurred. It has a uniform thickness, or occasionally the slightest possible taper, from base to apex, and appears to be solid and homogeneous in texture. It is apparently inflexible, and, even when carrying a single body, is united to it at a sharp angle with the longer axis of the latter (fig. 24^a).

Fissigemmation.—This is the only process of reproduction which has been observed. Several instances of this kind were partially followed through in an incidental way, and two complete courses were carefully noted and drawn within a half-hour of each other. The set of figures 13, 15, 17, 19, 21 relate to one individual, and figures 11, 12, 14, 16, 18, 20, 22 to another belonging to the same colony. The rate of progress of the former when the drawings were made was not noted; but that of the latter set was observed in four out of six of the intervals which occurred between the phases which the figures represent; and during the progressive steps of the latter it was carefully recorded which of the successive stages of the former filled the intervals between those of the latter; so that it can be said, in the strictest sense, that all the figures of both sets of observations represent the phases which were distinctly marked in the second series. In this way the fullest illustration possible was obtained, and no point was left unexplained. The whole time occupied by the process in the second series was *forty minutes*. It has already been mentioned, when describing the form of the collar, that it assumes a bulging campanulate outline (fig. 11, *b*) as a preparatory, preliminary act in fissigemmation. In addition to this, it should be stated that it widens inordinately at the distal end, so as to exceed by one-third its normal breadth; but before it finally settles itself into this shape and proportions, it contracts and expands its diameter by a peculiar sort of vibrating motion, and passes through a series of changes of form which vary from a funnel-shape to a narrower cylindrical outline, or from either of these to a broader cylindrical proportion,—such, for instance, as figures 9 and 10 (representing the same individual) exemplify. This would appear, also, to be the time when the contractile vesicles divide; for at no other period were they observed to be more than two in number, as they are represented in figs. 9 and 10 (*cv*).

Immediately after this preparatory sign was discovered (the time being noted at 12.55 P.M.), the flagellum became unusually conspicuous and much thicker, and moreover it lost its sigmoid flexure and assumed a perfectly straight carriage, with

the slightest possible tremulous vibratory motion. Within a very few minutes after this, the flagellum began to shorten as if retracting, reminding one of the running down of a cotton-thread in the flame of a candle, and in one minute's time it became reduced (fig. 12, *fl*) to a length which was somewhat less than half the height of the collar (*b*), and then it rapidly disappeared and left no trace of its former position. During this process the body shortened and became broader (fig. 12) in the same direction that the plane of the arc of the flagellum formerly trended in, and consequently the contractile vesicles (*cv*) were more widely separated; and the front (*fr*) also having become proportionately extended laterally, the base of the collar (*b*) was also increased in diameter until it almost equalled that of the distal end, so that, as a whole, it was almost cylindrical.

In less than fifteen minutes after the preparatory stage was observed, the collar had become cylindrical (fig. 13, *b*) by a combined action of the base and distal end, which consisted in a narrowing of the latter and a broadening of the former.

It was not until 1.15 P.M. that a decided mark of incipient self-division became evident in the guise of a narrow, slight furrow (fig. 14, *e*), which extended, medianly, from the front to over halfway toward the posterior end of the body. By this time the body had broadened until it was wider than long, and the collar (*b*), having followed this expansion at its basal portion whilst its upper extreme had contracted a little, had assumed the form of a high truncate cone.

In two or three minutes after this, the body had become distinctly indented (fig. 15, *e*¹) at the anterior termination of the furrow (fig. 15, *e*), and the latter had grown longer and more distinct, whilst the collar (*b*) had approximated more closely in shape to a perfect cone.

In another minute or two the anterior indentation (fig. 16, *e*¹) had become so deep and broad that the body presented a cordate outline when seen from its broader aspect, whilst the furrow (*e*) appeared to extend to its base, and the distal end of the collar (*b*) had so nearly closed up as to give that body an almost completely conical form, with a slightly collapsed periphery.

From this moment the process of reduction ceased; and soon after, the cone-shaped collar began to expand (fig. 17, *b*). Contemporaneously with this, the anterior indentation (*e*¹) had become sharper and deeper, and (with the lateral median furrow (*e*) of each of the opposing broad flanks of the infusorian acting in combination with it) had split the body about halfway to its base. The most remarkable phenomenon observable at

this time was what occurred at the rounded ends of the two half-separated bodies of the new pair of individuals. This was no more nor less than the incipient development of the flagellum, which proceeded in this wise:—At each of the rounded ends just mentioned a slight commotion appeared, resembling the molecular vibrations of a granule; and then there arose quite rapidly a sharp and distinct filamentous outgrowth (f), which kept itself in a constant state of narrow vibrations, or a sort of shivering.

By 1.23 P.M. the newly born flagella (fig. 18, f) had risen to half the height of the collar (b), and still remained in a shivering condition, whilst the body had divided almost to its base, and the collar had broadened to a widely terminating truncate cone.

In about a minute more, the dividing process had risen into the collar and split it (fig. 19, e^2) upwards for one-quarter of its height; and the still tremulous flagella (f) were slightly longer than in the last phase.

By 1.26 P.M. the body was divided (fig. 20) to its posterior termination, and the fission (e^2) of the collar (b) had reached half-way to the distal edge, and was further sketched out as it were by two opposing shallow longitudinal furrows, which extended to the margin. At this period the collar was broader at the still undivided portion than below; so that on the whole it had a very wide campanuliform shape, or rather (since the divided portion was rolled inwards at the opposing edges) was like two slightly flaring, broad funnels, merged into each other at their broader ends. The flagella (f) also had developed considerably, and extended a short distance beyond the collar; and the front end of the body, from the middle of which the flagellum arises, had assumed the low, truncate, conical shape of the adult form.

From this time onward the division did not appear to go forward so rapidly; and the new bodies seemed to be more particularly occupied in shaping themselves into the characteristic form of the adult. The collar, however, was not long in dividing itself up to its margin (fig. 21), but still the two cylindrical halves (b, b) did not separate at their extremes as soon as the fission reached that point.

At 1.35 P.M. the self-division was completed (fig. 22), as far as the body proper was concerned, and had extended a short way down the pedicel (pd^2). The margins of the two collars (b) seemed merely to lie in contact; and each collar had a slightly funnel-shaped outline, and was considerably more elevated in proportion to its diameter than in the adult form. The flagellum (f) was nearly as long as that of the full-grown body,

but yet had neither the sigmoid curve of the latter nor its stout and rigid aspect, but was much more delicate, and in fact still exhibited a slight tremulous motion. The two contractile vesicles (*cv*) of each body were as distinct as those of the adult, and had the same proportionate size and relative position.

In a very few minutes the two resultants were totally separated and divergent from each other at a sharp angle; and in less than half an hour after the last time noted, they had assumed the proportions of the other members of the colony. Shortly after the investigation of the phase just described, the last stages of self-division of another body, belonging to the same colony, were observed; and thus the group, which within two hours before consisted of five individuals, was increased to eight (fig. 7). It seems to be a rare occurrence that so many bodies remain long together, since it very seldom happens that more than four or five (fig. 8) are found in a colony; and now and then, in such instances, I have seen an individual drop off and swim away. When we meet with them settled down upon some point, amidst others which have scarcely any stem and those which are seated on very short peduncles, it becomes perfectly clear that they are there for the purpose of secreting a new support from the posterior end.

§ 7. *SALPINGÆCA*, nov. gen.

Salpingæca gracilis, nov. sp. Pl. VI. figs. 38, 39.

The difference between this genus and *Codonæca* has already been pointed out. It might well be compared to a stemless *Codosiga* (§ 6) enveloped in a sheath. I have met with three quite diverse species of this genus, of which that under present consideration and another (*S. amphoridium*, nov. sp., § 9) are freshwater denizens, and the third (*S. marina*, nov. sp., § 8) is a marine inhabitant. *S. gracilis* (figs. 38, 39) was found upon only one occasion, and then in an old aquarium, which could not be said to be in a perfectly healthy condition, although its contents were by no means putrid.

The *body* is yellow, and has a cylindrical shape, about four times as long as broad, narrowed and rounded behind, and rounded-truncate in front. Like *Codosiga* it bears a filmy, membranous, colourless collar (*b*), which is attached to the extreme edge of the frontal area (*fr*), and rises to a height which is equal to two-thirds of the length of the body. The outline of the collar is generally cylindrical, and truncate at the distal end, but still is subjected to various degrees

* σαλπιγγίς, a trumpet; οἰκέω, to inhabit.

of momentary change. Unless it be by means of the vibrations of the flagellum, there is no other immediate agent which can be supposed to move the body up and down in its sheath. There is no visible movement in itself, like creeping, to be observed; and moreover the body progresses so quickly, when changing its place in the calyx, that it becomes evident that it is not due to any reptant mode of transposition. When withdrawn (fig. 38) into the basal tapering portion of its calyx, the collar (*b*) does not extend beyond the rim (*c*¹) of the latter, but, on the other hand, the body occasionally moves so far in the opposite direction (fig. 39) that nearly the whole of the collar (*b*) projects outside of the dormitory.

The *flagellum* is a delicate filament which arises from the axial point of the front, and projects a short distance beyond the edge of the collar. It presents a constantly undulating aspect, and vibrates from base to tip.

The *mouth*, we are obliged to presume, as we did in regard to *Codosiga*, lies somewhere about the base of the flagellum. Abundant digestive vacuoles were observed, as well as loose particles of food, in various parts of the body; but at no time were we so fortunate as to see the introception of nutritive material or the ejection of fæcal matter.

The *contractile vesicles* (*cv*) are two in number. They lie between the second and posterior thirds of the body, usually on opposite sides, and close to the surface. In aspect and rate of systole they resemble those of *Codosiga pulcherrima*, but they are a little smaller in proportion to the size of the animalcule. Sometimes the protean changes of the body are so extensive as to throw the two vesicles into a line with each other in an antero-posterior direction; but they hold this position only temporarily, and soon return to their normal relations.

The *calyx* (*c* *c*¹ *c*²) has the general shape and proportions of a champagne-glass, and appears to be hollow to the very bottom (*c*²) of its pedicel-like inferior third. Anteriorly it is truncate, smooth, and flares (*c*¹) quite strongly. About the middle it bulges very sensibly, and thence tapers gradually into a slender posterior third (*c*²), but expands again slightly as it terminates upon its place of attachment. It is colourless, excessively transparent, and exhibits considerable flexibility under the movements of the body, apparently having the consistency of a mere film.

§ 8. *Salpingoeca marina*, nov. sp. (Pl. VI. figs. 28-32*.)

The remarkable generic resemblance of this species to *Codosiga* has already (p. 193) been commented upon. It is very common, especially upon the marine Hydromedusa *Dynamena*

pumila, Lamx., but is so excessively minute, and withal so transparent, excepting the body proper, that under a magnifying-power of five hundred diameters it appears to the casual observer like a mere globular speck. It was discovered when searching after specimens of *Codonæca costata* with a power of eight hundred diameters. Although sometimes met with in groups of forty or fifty, it always appeared single. In its general aspect it may be compared to an oval flask which is supported by a slender stem (*pd*), and has a broad funnel inserted in its mouth. Upon close inspection we find that the funnel (*b*) is a direct projection from the body (which hangs freely within the flask, *c c'*), and is in no way connected with the latter.

The *body* proper has a dark fuscous colour, and consequently is quite conspicuous. It is mainly oval in shape, but is constricted anteriorly into a short thick neck (*i*), which terminates in a truncate front. It hangs quite loosely within the calycle (*c*), and usually at a considerable distance from its parietes; but at the mouth (figs. 31, 32, *c'*) of the latter the neck (*i*) presses so closely against it as to seem, without the most careful scrutiny, to form a continuation with it. Occasionally, however, the neck narrows and retreats from the aperture of the calycle to such a degree as to allow a clear and unmistakeable view (fig. 32) of the relations of the former to the latter.

The *collar* (*b*), which has just now been likened to a funnel set in the mouth of the flask-shaped calyx, is most frequently seen in a very broadly expanded state (fig. 28, *b*), in outline resembling a low, obtuse-angled, truncate cone inverted upon the front of the body. It arises from the extreme circular margin of the head (*i*), and, widening to about twice the equatorial diameter of the calyx (*c*), terminates in a smooth edge at an altitude which is hardly equal to one-quarter of the width of its distal expanse. It is hyaline, and so extremely thin and filmy as to require the most careful manipulation of the light, even with so high a power as eight hundred diameters, in order to define its boundaries clearly. In its plasticity it is even more marvellous than that of *Codosiga*; at least it exhibits it over a far wider lateral range than the latter, and with equal rapidity in its changes. In a few seconds it narrows from its greatest expanse to the proportions of an obverted acute-angled cone (fig. 29, *b*), and at the same time assumes an altitude which is equal to the length of the body; and then, within an equally short period, it contracts into the form of a cylinder (fig. 30, *b*) whose height more than equals that of the calyx. These changes are carried on with the same peculiar vibrations as were noted in regard to *Codosiga*, reminding one of the

glimmering outlines of the prongs of a tuning-fork when vibrating. When observed with a poorly defining lens, I can readily see that this phenomenon might be mistaken for the cone of light produced by the gyratory vibrations of a single filament, or for the bright *lumen* of a circular row of vibrating cilia. As regards the former category, it may be said that the flagellum is far more conspicuous than the collar, and may be seen clearly projecting in the line of the axis of the body, and vibrating after a manner of its own. As for the latter supposed case, one might be inclined to dismiss it without any scruple, upon the simple assumption that no flagellate infusorian can bear numerous cilia, were it not that I call to mind my own discovery of a flagellated animalcule (*Heteromastix*, figs. 70-74) of the heteronematous form, which is at the same time abundantly ciliated. I have therefore taken all possible pains to ascertain that this "collar" (figs. 28-32, *b*) is a genuine membrane, and not the similitude of one.

Occasionally individuals (fig. 32) were seen which bore an inverted conical collar (*b*) that remained, at least for a time, at an expansion and altitude equal to the breadth and height of the calyx (*c*). These were among the largest specimens found, and almost or altogether filled the calyx. Rarely were examples found which crowded the calyx so fully as to seem to bulge it out laterally. Figure 31 represents such an instance, in which the aperture (*c*¹) of the calyx is absolutely inseparable from the head, excepting that, knowing that it is not really continuous, one recognizes the line of demarcation by the abrupt change in the thickness of the seemingly uninterrupted membrane. This case is also remarkable, inasmuch as it at the same time furnishes us with an example of an enormously large, bulging, campanulate collar, nearly as broad as the most common and normally permanent form (fig. 28), and yet higher than it is wide. In all probability, judging from appearances, which in every respect remind one of the preparatory steps of fission of *Codosiga pulcherrima*, this individual is soon about to undergo self-division. Unfortunately the drawing was made at a time when the impending process could not be watched.

The flagellum (*f*) is as highly flexible as that of *S. gracilis*, and very active throughout its length. It is attached to a more or less elevated axial prominence in the middle of the frontal area, and extends to a length which is at most not more than one-third greater than that of the body.

Regarding the digestive organs nothing can be said, excepting that dark irregular pellets and loose foreign material were abundant enough, and so irregularly scattered that they could not be looked upon otherwise than as nutritive matter.

The *contractile vesicles* (*cv*) are two or three globular bodies, which, in appearance, position, relative size, and rate of systole, may be compared with those of *Codosiga pulcherrima*. On one occasion (fig. 30) they amounted to four (*cv*) in number, and were arranged in pairs, one above the other.

The *calyx* (*c*¹) usually has the form of a Florence flask, but with a very short, thick neck, which flares (*c*¹) slightly at the aperture. It sometimes, however, is slightly pointed at its base where it joins the pedicel (*pd*). When not filled by the head (fig. 32, *i*) of the animalcule, the neck and the sharp margin (*c*¹) of its aperture may be clearly distinguished from the collar (*b*) which rises just above them; but very frequently this discrimination is attended with a good deal of difficulty, because when the body presses closely at this point, it overlaps the margin in question, and obscures it. The pedicel (*pd*) is not much longer than the calyx, and joins the latter with little or no expansion. It is colourless like the calyx, moderately slender, of a uniform diameter from top to bottom, and appears to be solid and homogeneous in texture. Figure 32^a represents one of three bodies which were found in the midst of several living animals of this species, and which had every appearance of being the deserted calyces of the same, with a collapsed aperture. In the next species (*S. amphoridium*) the deserted calyces (fig. 37^c) were found so numerous among those which were occupied, and moreover retaining the shape of the latter so perfectly, that there could be no doubt that the calyx is not only a separate organism apart from the body-wall, but also may be as readily vacated as that of *Cothurnia* or

§ 9. *Salpingæca amphoridium*, nov. sp. Pl. VI. figs. 37-37^d.

Although this species bears a strong resemblance to *S. marina* (§ 8), there are several prominent points of difference between the two. *S. amphoridium* is a freshwater form, and appears especially to frequent old specimens of *Zygnema* and other filamentous Algae. It is very common in such places, and lives in more or less crowded groups. Excepting the main part of the body, it is very transparent, but not so faint as *S. marina*. It varies much in size, even down to half that of fig. 37^a. Like its marine congener it always occurs single, and never with a trace of a pedicel to the calyx (*c*¹). As a compensation for this, if one may use the expression, it has a long neck, which is frequently seen bending from side to side (fig. 37^b, *i*) with a gentle motion, and apparently in search of something.

The *body* is grey or greenish yellow in colour, which fades

in the neck (*i*) and disappears altogether in the collar (*b*). In its general aspect the body with its collar might be compared to a wine-glass with a long stem and a globose pedestal. The globose part is the posterior half of the body; and the stem is its neck, or anterior half, which tapers rapidly from the main part to one-quarter or one-fifth its diameter, and then gradually widens to nearly double that thickness at its front, where the collar is set on. The *front* is truncate, or rises into a low cone, upon which the flagellum (*f*) is based. The posterior half of the body usually fills the bottom of the calyx (*c*); but the rest and the neck (*i*) stand off from it at a very appreciable distance. In this respect there is a marked difference between this species and *S. marina* (§ 8). In the latter we might say that the body is suspended from the aperture of the urceolus; but in the former it rests on the bottom of the calycle. Not unfrequently, however, the whole body of this species lies loosely within its calyx (fig. 37).

The *collar* (*b*) is an excessively hyaline, filmy membrane, whose distal margin is so extremely delicate as to almost defy detection with the highest powers. In the latter respect it is a more difficult object of research than that of *S. marina*. Generally speaking, it may be described as obconical, but with greatly varying degrees of width. In this relation it agrees perfectly with that of *S. marina*, and therefore need not be redescribed here. At its greatest height it equals that of the body, and always terminates in a smooth edge. In plasticity it is also equal to that of the marine species. In one instance, when the animal was disturbed by a predaceous Rotifer, its whole body quickly retracted, and the collar totally disappeared, as if melted down with great rapidity, but soon after protruded slowly, at first with a broad base (fig. 37^d, *b*), and then rapidly narrowed at the latter point and assumed its usual proportions.

The *flagellum* (*f*) differs from that of *S. marina*, both in proportions and deportment. It is usually rigid, and projects considerably beyond the collar when the latter is at its greatest height. It has a decided arcuate figure, with a uniform thickness throughout, excepting near the base, which tapers rapidly from the low cone in the middle of the front. Its apex moves with quite gentle spasmodic twitches, and the whole becomes flexible (fig. 37^b, *f*) when fæces are ejected or some undesirable particle enters the area within the collar.

The *mouth* was not actually seen; but that it exists somewhere about the base of the flagellum was sufficiently demonstrated by minute particles of food being seen thrown by the latter organ against the front, and rapidly disappearing there. The *anus* (fig. 37, *a*) certainly opens within the same area, as parti-

cles of considerable size were seen to make their exit at the base of the flagellum. No digestive vacuoles were noticed, although the body was often found filled with food.

The *contractile vesicles* (*cv*) usually amount to three or four, and rarely to five in number; or there are two very large ones, which occupy nearly the whole breadth of the body (fig. 37^a). They occur in all parts of the body except its neck, and beat with a sluggish systole about at the same rate as those of *Codosiga* (§ 6).

The *calyx* (*c*, *c*¹) has very much the same proportions as the body, over which it is fitted as if upon a mould. Its posterior half (*c*) is globular, and is attached at its hindermost, axial termination to the point of support. Although hundreds of specimens of this species were observed, not one of them had a pedicel. The anterior half tapers, like the thick neck of an urn, from the posterior one to one-third of its diameter, and then rapidly widens and terminates with a flaring, smooth-edged aperture (*c*¹), which is about twice as wide as its narrowest portion. The margin usually is exceeded by the projecting head, so that the former may be seen quite readily as a distinct ring behind the circular edge of the front, from which the collar rises. The empty calyces (fig. 37^c) were found very frequently, and so nearly identical in form with those of the living body that they must have possessed considerable rigidity. That they are, however, to a certain extent flexible and plastic, was shown on one occasion, when the body and neck suddenly retracted and swelled laterally (fig. 37^d) to an extent which was considerably beyond the usual breadth of the calyx and its neck, and then returned to its former shape and proportions.

§ 10. *Leucosolenia* (*Grantia*) *botryoides*, Bowerbank.

Pl. VI. figs. 40–44; Pl. VII. fig. 64.

If I were now to describe merely the congregated Monads of this compound animal without giving it a name, any one who had already become acquainted with the structure of *Codosiga* (§ 6) would set down the first as a colonial, massive form of the latter. In fact a glance at a figure of a free-swimming individual (fig. 23) of *Codosiga* in one of its numerous attitudes, and then a momentary inspection of the monad (figs. 42, 43, 44) of this Sponge would almost induce one to believe that the two belonged to the same genus, nay, even to the same species, as far as the representations referred to are concerned.

In the introductory section of this memoir I have already discussed the theory of Carter as to the alliance of Sponges

with Rhizopods, and I will therefore only state here my firm conviction that the true ciliated *Spongiæ* are not *Rhizopoda* in any sense whatever, nor even closely related to them, but are genuine, compound *flagellate Protozoa*, and are most intimately allied to such genera as *Monas* (§§ 1, 2), *Bicosæca* (§§ 3, 4), *Codonæca* (§ 5), *Codosiga* (§ 6), and *Salpingæca* (§§ 7, 8, 9). What are the special relationships of the numerous genera of Sponges I am not prepared to say; yet, in regard to *Leucosolenia botryoides*, there can be no doubt that it is very closely allied to *Codosiga* and *Salpingæca*; but to which one more than to the other would be difficult to determine. *Codosiga* (§ 6) is a compound form like *Leucosolenia*, and its individuals are united by a common branching support, which has been shown, by the changes which it passed through during fissigemmation, to be as fully alive as the glairy, spicule-secreting cytoblastema of the Sponge. *Salpingæca* (§§ 7, 8, 9), on the other hand, is a single monad, but excretes around it an envelope, or *calyx*, into which the body is sunken in the same way that the monads (fig. 41, *md*) of the Sponge are imbedded in the surface of their common dormitory. Inasmuch, however, as the calyx is probably an excretion rather than a secretion, and appears as inanimate as that of *Cothurnia*, *Vaginicola*, and other Vorticellidæ, it is more comparable to the *spicula* (*sp*) than to the *cytoblastema* of Sponges. If one may draw an inference from the above considerations, it does not seem at all improbable that hereafter we shall find that the monads of the different genera of Sponges resemble the various genera of single and branching Flagellata; and then we shall be able to divide the former into such family groups as Monadoidæ, Bicosæcoidæ, Codosigoidæ, Anthophysoidæ, &c. &c.

Leucosolenia botryoides, Bowerbank, occurs on our sea-shore among the groups of *Dynamena*, *Sertularia*, &c., and may be readily recognized by its ivory-white colour. The colony is an elongate mass, seldom exceeds an inch or an inch and a half in length, and resembles an irregular group of slender contorted spines or forked horns (fig. 40), which vary in thickness from one-thirtieth to one-sixteenth of an inch in diameter. At the tip of each horn is an aperture, the so-called excurrent orifice, large enough to be seen by the unassisted eye. The whole mass is so transparent that not only the currents in the interior, but even the vibrating flagella and the pulsation of the contractile vesicles, may be seen with a strong light. The exterior consists of an excessively hyaline, cytoblastematous layer, with scarcely, if any, trace of organization of a cell-like character in it. Within this layer, or immediately beneath it, but certainly not in the monadigerous

stratum, the faint yellow *spicula* (fig. 64, *sp*, *sp*¹) are imbedded in systematic order, and overlap each other irregularly in two or three layers. They present two diverse forms—namely, a simple aciculate shape (*sp*¹) and a stellato-triradiate (*sp*) one. The rays of the latter are slender, tapering frequently to a bifid termination, divergent at equal angles from each other, and lie in the same plane. Without exception they are all arranged with one ray (often longer than the others) projecting backwards, *i. e.* away from the excurrent orifice, and the other two extending symmetrically right and left, and obliquely transverse to the longer axis of the branch. In this manner they are disposed in a sort of network over the whole colony, even close up to the excurrent orifices; and as the aciculate spicula lie parallel with the rays of the other kind, there are consequently no projecting spines specially devoted to guarding the entrance to these apertures.

The *ostioles* (fig. 64, *o*), or incurrent channels, are very numerous, there being at least two, and often three, opposite to every interstice of the spicula. They are very small, but quite conspicuous, especially at their inner ends, where they plunge through the monadigerous layer (*md*). They afford great assistance whilst studying the contractile vesicles and the action of the flagella, since they enable one to get a freer view of the monads in an undisturbed state than where they are observed through all the tissues. It should be mentioned, however, in this connexion, that the profile view (fig. 41) of the monads was obtained by making an actual section of one of the younger branches and allowing it to revive and expand in a fresh supply of sea-water.

The *monadigerous layer* (figs. 41, 64, *md*) lines the cavity of the body; and it is by the combined action of the vibrating flagella (*f*) of the monads that currents of water and floating particles are kept up. This layer is composed of monadiform animalcules (*md*), packed closely side by side in a vast colony, which extends over the whole length and breadth of the general mass. In this respect we are reminded of the similar arrangement of the individuals of that floating Ascidian, *Pyrosoma*. These monads crowd so closely upon each other that their sides are mutually compressed, and they thus form a sort of irregular polygonated pavement (fig. 64, *md*). They all lie with the anterior end (*fr*) turned inwardly and projecting into the general cavity, and the posterior extremity imbedded in the cytoblastematous, external, general envelope.

The *body* of a monad is yellow when seen by transmitted light, and in general terms may be designated as broadly oval, with the longer axis extending antero-posteriorly. Behind it

is broadly rounded, at the sides lightly indented and irregularly polygonal by mutual contact with others, and extended in front into a delicate, membranous, circular collar (*b b'*), which might be compared to a transverse section of a tube which is about as long as it is broad. This *collar* is capable of variations in form, like that of *Codosiga* (§ 6) and *Salpingæca* (§§ 7, 8, 9), at one moment assuming a truncate conical shape (figs. 43, 44, *b*), and in the next instant expanding its distal margin into a distinct flare (fig. 42, *b*) which is at least two-thirds as wide as the body; or, finally, it retracts altogether and disappears for a while, but eventually reappears and expands to its fullest dimensions*.

The *flagellum* (*f*) is the only prehensile organ which the monad possesses. It arises from the middle of the frontal area, and extends to a great length, at least five or six times as long as the body, with scarcely any diminution in thickness. It is a comparatively thick filament, and quite conspicuous, on which account it is so easily seen through the whole mass of the colony. It usually vibrates with considerable vigour from base to tip, but occasionally assumes the quiescent state and arcuate form so eminently characteristic of that of *Codosiga* (§ 6), *Bicosæca* (§ 3), and others.

The *mouth* is the only organ which has not been actually observed, although its position has been inferred, not only from the otherwise similar structure of the monad of this creature to that of *Codosiga* (§ 6), but because currents of floating particles are constantly whirled in by the flagellum and made to impinge upon the area within the collar. In addition to this it may be added that more or less numerous coarse and fine particles (fig. 44, *d*) are always present and scattered irregularly about the interior of the monads, apparently under various degrees of digestive decomposition.

The *contractile vesicles* (*cv*) are two in number, and lie near

* In this connexion it may be well to mention the latest decision of Carter in regard to the structure of the monociliated sponge-cell. In the *Annals and Magazine of Natural History*, vol. xx. 1857, pl. 1. figs. 10, 11, this cell is represented as an oval body, with a single ciliary appendage; but in a subsequent communication to the same periodical (vol. iii. 1859, p. 14, pl. 1. figs. 12, 13, 14), a partial recantation seems to be made, and the cell in question is figured with "two spines or ear-like points projecting backwards, one on each side of the root of the cilium." If, now, we suppose these "two spines" to be the right and left profiles of a membranous, cylindrical collar, such as I have described in *Leucosolenia*, then it follows that the monociliated sponge-cell of *Spongilla* is like that of the former. That Carter did not always find these "two spines," may be explained by the fact that the membranous collar, as I am inclined to believe the "spines" to be, was retracted, since I have frequently observed this to happen in the case of *Leucosolenia* when it was disturbed.

each other, at or about the middle of the body. When fully expanded, they are from one-fifth to one-fourth the diameter of the monad, and have a perfectly globular shape. In appearance, and manner and rate of systole and diastole, they resemble those of *Codosiga* so closely that the former might be substituted for the latter with scarcely a chance for a detection of the change. As the rate of systole of each vesicle, which is once in half a minute, was observed directly through the undisturbed layers of the colony, and moreover at the edge of the ostioles, there need be no hesitation in accepting the record as that of the normal measure of pulsation.

§ 11. *Anthophysa Mülleri*, Bory. Pl. VI. figs. 47-61 ;
Pl. VII. figs. 62, 63.

A description of this infusorian, but without illustrations, has already been published in the 'Annals' for December 1866. In order to carry out the object of this memoir to its fullest extent, I propose here to make quite large extracts from this paper, and also to add a number of figures, both for the better understanding of the character of the animal and for the sake of comparison with others which are illustrated in the accompanying plates.

The mononematous *Flagellata* which are described in the foregoing pages (§§ 1-10) are connected with the heteronematous forms through two diverse lines; or, rather, they are closely allied to two different types of *diversiflagellate* Infusoria, of which *Anthophysa* is an example of one type, and *Anisonema* (§ 13) a representative of the other—both of the flagella of the former being proboscidiiform, and, of the latter, one being gubernaculiiform and the other proboscidiiform. The intimate alliance of *Anthophysa* with *Monas* may be best expressed by saying that the former is a *Monas* modified by the addition of a comparatively minute *cilium*, which is affixed to the head near the *flagellum*.

Anthophysa Mülleri, Bory (*Epistylis? vegetans*, Ehr.), is quite common among freshwater plants, such as *Myriophyllum*, *Ceratophyllum*, and *Utricularia*, and adheres to their filiform leaves like an irregular, floccose, brownish deposit.

"Under a low magnifying-power this floccose matter appears to consist of clusters of very jagged, irregularly branching and contorted, semitransparent, intertwined stems, and projecting tapering and flexible twigs (*pd*). Each of the tips of the latter sustains a single, more or less globose mass of spindle-shaped bodies (*md*), which radiate from a common centre of attachment, and are kept in a constant agitation by the spasmodic jerks of a long, stout, usually rigid, arcuate filament (*f*),

with which the free end of each one is endowed. The whole bristling mass revolves alternately from right to left and from left to right, whirling upon its slender pivot with such a degree of freedom that one might almost suspect that it merely rested upon it, and had no truer adhesion to it than the juggler's top to the end of the *bâton* upon which it spins. The largest of these twirling groups contains as many as fifty fusiform bodies; but most frequently not more than half that number are grouped together; and from this they vary in decreasing numbers down to only one or two (fig. 48) upon each filamentous twig. In the last instances the bodies are comparatively quiet, scarcely moving out of focus at each spasmodic twitch of the arcuate filament. On this account, and because they offer an unobstructed view, the latter are by far the most available as objects for the investigation of their internal organization.

"The relationship of the individual monads to the whole colony must, however, be studied where they are more numerous congregated, since, as will be shown presently, each monad sustains a definite relation to every other one and to the twig to which it is attached."

"*Form &c.*—The adult monads (figs. 47, 48, *md*) have a truncate fusiform shape, and are slightly but quite appreciably flattened on two opposite sides, so that, in an end view, they appear to be broadly oval transversely. The attached end tapers gradually to a point; and on this account it is difficult to determine where the body ends and the twig begins. All of the members of a group radiate from a common point of attachment, to which they adhere by their tapering filamentous ends (fig. 48, *pd*¹). The free end is truncate; but one corner of it (as if in continuation of the line along which the opposite flattened sides meet) projects in the form of a rather blunt triangular beak (*lp*). At the inner edge of the base of this beak lies the mouth (*m*), to which the former, as frequent observation has proved, acts as a lip or prehensile organ when food is taken into the body. The prevailing tint is a more or less uniform light gamboge, without the least trace of an eye-spot of any colour.

"A most singular uniformity prevails in the arrangement of the several members of a group. Each monad (*md*) is attached to its mooring in such a position that its flattened sides lie parallelwise with those of its nearest neighbour; and the beak (*lp*) projects from that corner of the head which is most distant from the twig (*pd*). To give a full idea of the peculiarity of this arrangement, it must be stated here that the rigid, arcuate, spasmodically twitching filament (*f*) mentioned

above is attached close to the mouth (*m*), and invariably curves away from the beak, and consequently always towards the pedicel (*pd*) of the colony."

"*Prehensile organs.*—The only motile organs which this animalcule possesses are preeminently prehensile in character; and their apparent appropriation to the office of propulsion, when a colony breaks loose from its attachment, I can scarcely doubt is an accidental one, inasmuch as the arcuate cilium continues its spasmodic twitching without any apparent deviation from its usual mode of action.

"There are two cilia, of very unequal size, attached to the truncate end of the body. The larger one of these has already been mentioned casually, as a *rigid, arcuate filament* (*f*). It does not taper, but has a uniform thickness from base to tip, and is about half as long again as the body. It arises near the base of the triangular beak (*p*), but appears to be separated from the latter by the intervening mouth (*m*). When quiet, it appears like a bristle, and projects in a line with the longer axis of the body—at the base bending slightly toward the beak, and then sweeping off in a moderate but distinct curve in the opposite direction, so that on the whole it presents a long, drawn-out sigmoid flexure. The plane of this curve lies in strict parallelism with the plane of the greater diameter of the body; in fact it may be said to be a direct continuation of it. It does not appear to have the character of a *flagellum*, except when assisting the smaller cilium (*f*¹) to convey the food to the mouth; and then it lays aside its rigid deportment, and assumes all the flexibility and wavy vibration of the prehensile organ of an *Astasia*.

"*The smaller cilium* (*f*¹) is an excessively faint body, and almost defies the detective powers of the highest objectives. This is partly due to its almost incessant activity; for when it is quiet or nearly so (which happens when food is passing into the mouth), it becomes comparatively quite conspicuous under a one-eighth-of-an-inch objective. It is scarcely as long as the greater diameter of the truncate end of the body. It arises close to the base of the larger cilium (*f*); but whether on the right or left, or nearer or more distant from the mouth than the latter, cannot be said positively. Most frequently it was observed to be flexed in the same direction as its companion; and occasionally it seemed to be quite evident that it was attached nearer to the mouth than the latter. It is highly flexible, and vibrates with great rapidity in what appears to be a gyratory manner.

"*The mouth.*—This organ is never visible except when food is passing through it (figs. 50, 51, *m*). It then may be seen that it lies close to the beak, which acts as a sort of lip

by curving over the introcepted particles as they pass into the body. The mouth is highly distensible, at times allowing particles as wide as two-thirds the greater diameter of the body to pass in without any apparent extra effort (fig. 51, *m*). It seems undeniable that it possesses discriminative powers in regard to the quality of its food. This one may readily judge of for himself by seeing the unerring precision with which the particles of floating matter are thrown, by the spasmodic incurvature of the larger flagellum, against the mouth, where, if they are not swallowed, they are detained but for an instant by the smaller cilium, quickly adjudged to be worthless, and then thrown off with a twirl of the organ which held them in temporary abeyance. If, however, the captured morsel proves to be agreeable, the larger cilium (fig. 47, *f*) assists the operations of the smaller one (*f*¹) and the lip, by abruptly bending itself at its point of attachment and laying its basal part across the food, pressing it into the mouth, while the terminal portion is kept in a constant wavy vibration, and curved towards the posterior end of the body. This is usually done in three or four seconds; and then the cilia return to their usual positions, while the introcepted edible passes towards the centre of the body, and is there immediately enclosed in a digestive vacuole (fig. 51, *d*). For a while the food dances about in this vacuole with a very lively motion, but finally it subsides into quietude.

"*The contractile vesicle* (*cv*).—There is a twofold difficulty in discovering the presence of this organ. In the first place, it is comparatively quite small; and, secondly, it pulsates so slowly that it is very rarely possible to see it contract twice in succession between any two of the abrupt lateral deviations of the body which the spasmodic twitchings of the arcuate flagellum produce. On this account it has not been possible to determine the precise rate of its systole and diastole. It seems to contract from three to four times a minute. It lies near the surface, about halfway between the two ends of the body, and nearly midway between the two extremes of its greater diameter. At the completion of its *diastole* it has a circular outline, and appears like a clear colourless vesicle in the midst of the yellowish tissue of the body. Upon contraction it disappears, and leaves no trace of its presence. The *systole* progresses slowly, as in *Anisonema* (*A. sulcatum*, Duj.?, and *A. nov. sp.* [*A. concavum*, § 13]), *Cyclidium* (*C. nov. sp.*), and *Phacus pleuronectes*, Duj., and in this respect contrasts strongly with the same process in *Heteromita fusiformis*, Jas.-Clk., *Astasia tricophora*, Clap. (§ 12), and *Cryptomonas* (*C. nov. sp.*), in which the last half of the systole is very abrupt and marked.

"*The stem*.—In addition to what has already been said of

the general appearance of this part of the organism, it may be added that the older and basal portions (fig. 63) of the branches are flat, and have a distinct longitudinal irregular striation, to all appearance made up of the older, laterally agglutinated twigs. The youngest, terminal portions (fig. 47, *pd*) of the branches which, under the name of twigs, have been described in this paper as the immediate supporters of the colonies of monads, are evidently tubular (fig. 62). They appear to be as flexible as a spider's thread, and are usually quite irregular in outline, and in the calibre of the canal which permeates them. The wall of these tubular twigs is quite thick, and is alike rough on the exterior and interior faces. The substance within the tubes appears homogeneous, but whether it is solid or fluid could not be determined. The oldest part of the stems is of a reddish-brown colour; but as they taper off into branchlets they gradually assume a gamboge-colour, and finally terminate in scarcely coloured twigs.

"*Reproduction* by fission (figs. 52-61) is the only method of propagating individuals which I have observed. As a preliminary to this process the monad gradually loses its fusiform shape, and assumes at first an oval contour, and finally becomes globular (fig. 52). During this transition, both of the prehensile cilia (*f*, *f*¹) become much more conspicuous than usual; and the body develops a closely fitting hyaline envelope (*h*) about it, thus passing into a sort of encysted state. The contractile vesicle (*cv*), however, does not seem to cease its pulsations during this period, and moreover it becomes quite conspicuous. This arises mostly from the fact that the body is in a nearly quiet state, and allows the observer to obtain a prolonged and undisturbed view of it. Unfortunately the rate of the pulsations of this organ was not ascertained when the following observations were made, because the whole time was occupied in watching and drawing the various and rapidly changing phases of self-division.

"After the body assumes a globular shape, as above-mentioned, both the larger and smaller cilium seem to be undergoing a change, and become indistinct in outline. Presently two larger flagella (fig. 53, *f*) burst upon the view, apparently by the longitudinal splitting of the previously single one of the same kind, and rapidly separate from each other by the broadening of the body, leaving between them the smaller cilium. The latter at this time appears much thicker than usual, and seems to be composed of two closely approximated parallel threads (*f*¹). By this time the contractile vesicle has also divided into two, which lie closely side by side.

"At this moment the time noted in one series of observa-

tions was 2.30 P.M. By 2.35 P.M. (fig. 54) the larger flagella (*f*) had separated still further, and the smaller cilium had split into two (*f*¹) very conspicuous filaments, as yet, however, attached to a common point of the body. From this time forth to the completion of the process of fissigemmation all of the cilia kept up a slow vibration, in which they undulated from base to tip with a sort of snake-like motion. By 2.45 P.M. (fig. 55) the body had become quite appreciably broader than long, the contractile vesicles (*cv*) were widely separated, and the smaller cilia had left between them a considerable space, and each one had approximated quite near to the base of a larger flagellum. At 2.50 P.M. (fig. 56) the body had become nearly twice as broad as long, and the space (*e*¹) between the two pairs of cilia was nearly twice as great as in the last phase, and considerably depressed in the middle, so that the body had a broadly cordate outline. By 2.52 P.M. (fig. 57) the posterior end of the body (at a point a little to one side of the spot where it was attached to the pedicel) was also slightly indented, so that in outline it presented a guitar-shaped figure, each rounded half of which bore a pair of unequal cilia, and contained a contractile vesicle. In one minute more the contraction had increased to such an extent that the body was divided about halfway through (fig. 58). By 2.54 P.M. (fig. 59) the animal had a dumb-bell shape, and the pedicel (*pd*) was attached to one of the segments near the point of constriction. Still the process went on very rapidly, and by 2.55 P.M. (fig. 60) the new bodies were widely separated, but still attached to each other by a mere thread. At 3 P.M. (fig. 61) the body which was attached to the pedicel was left alone, and its companion swam away to seek a new attachment and build up its stem.

"To the last moment the hyaline envelope remained about the segments, and in fact so long afterwards that time and circumstances did not allow me to ascertain its final disposition. I would remark, however, that when the ovate bodies of the half-grown monads (fig. 49) are contracted temporarily into a globular shape, they appear identical (excepting that they lack the hyaline envelope) with these recently fissed forms. In all probability, therefore, the latter lose their envelope and assume the shape of the former.

"As to the development of the stem, I think it quite certain that it grows out from the posterior end of the body. The best proof of this is, that I have frequently found a monad (especially in the condition of the one which I described above as breaking loose from its companion) nearly sessile upon a clean spot, and attached by a very short, faint, film-like

thread. From this size upward I have no difficulty in finding abundant examples as gradually increasing in diameter as they did in length—thus furnishing a pretty strong evidence that the stem grows under the influence of its own innate powers, and is not, therefore, a deposit emanating from the body of the monad, except, perhaps, as far as it may be nourished by a fluid circulating within its hollow core."

[To be continued.]

XXVIII.—*Observations on the Fur-Seals of the Antarctic Seas and the Cape of Good Hope, with the Description of a new Species.* By Dr. J. E. GRAY, F.R.S., V.P.Z.S.

FURTHER research and additional specimens have shown that, with all the attention I had bestowed on the Seals which had been named *Phoca falklandica*, I have some additions which require to be made to my former paper.

Capt. Abbot assures me that there were only three kinds of Seals found in the Falkland Islands when he was there, about ten years ago,—viz. (1) the Sea-Bear (*Otaria jubata*), (2) the Fur-Seal (*Arctocephalus nigrescens*), which are Eared Seals, and (3) the Sea-Leopard (*Stenorhynchus leptonyx*), which is an Earless Hair-Seal.

According to Pernetty (Voy. aux îles Malouines, p. 202), Sea-Lions or Sea-Elephants (*Morunga elephantina*) were found there in his time: they may have been driven away or all destroyed by the sealers; and some other species that formerly lived in the islands may have shared the same fate. If that is the case, the beautiful Fur-Seal in the British Museum which I have named *Arctocephalus falklandicus* is not now found in the Falkland Islands, though it was received as a Seal from there. On my showing Mr. Bartlett the specimen, he brought me a furrier's small imperfect skin of the same species, which he had purchased of a fellmonger, who assured him that such Fur-Seal skins were only received from the arctic part of the Pacific Ocean. If this be true, the skin was probably that of a young individual either of Steller's Sea-Bear (*Eumetopias Stelleri*) or of a species allied to it, which, as I mentioned in my former paper, are the only Seals that have such a close, soft, elastic fur.

The statement that the Museum specimen of *Arctocephalus falklandicus* was not a Falkland but a northern species renders it necessary that further research should be made to determine the two specimens in the Museum of Science and Art at Edinburgh, which were, according to Mr. R. Hamilton, conveyed to

this country and deposited in this museum by Capt. Weddell, the enterprising navigator who visited the Antarctic regions in 1823. They are both females, and were prepared in Edinburgh and described by Mr. R. Hamilton in this Journal (as referred to in the former paper), who observes that "the personal observation of Capt. Weddell enabled him at once to identify the [*Phoca*] *faulklandica* with his Fur-Seal" (see Ann. Nat. Hist. 1838, vol. ii. p. 91). I do not find it stated whence Capt. Weddell procured these specimens; it is only said that "he encountered the Fur-Seal in South Georgia, among the South Orkneys, and in much greater numbers in the South Shetland Islands, which he was the first to discover" (*ibid.* p. 84-85); and he expressly states that the only Seal inhabiting the last-named islands is the Fur-Seal; so that probably the specimen he gave to the Edinburgh Museum came from either South Georgia or the South Shetlands.

I wrote to my friend Mr. Thomas C. Archer, the Director of the Edinburgh Museum of Science and Arts, to ask him if he would kindly send me a few hairs from one of these Seals; he most readily acceded to my request by return of post, accompanied by an offer to send one of the Seals to the Museum for examination, if I wished it. As the hairs alone showed that the Seal was not like any other of the South-American Seals that I had described in my former paper, being most like those of the Seal to which I had referred it, but still appearing rather harsher, I most gladly accepted his very kind and liberal offer.

I was much pleased, when the specimen arrived, to find that it evidently is the same as my *Arctocephalus falklandicus*, and that my reference to Mr. R. Hamilton's description and figure was correct. The fur in this specimen is considerably darker and harsher than in that in the British Museum; but this may arise from the animal having been stuffed and exhibited for many years, and, perhaps, collected at a different time of year. In every other respect, both as to the form and size of the limbs (which are small compared with the size of the body) and the distribution of the colours, they agree.

This animal, which was brought from the Antarctic Ocean, may formerly have inhabited the Falkland Islands, and, like the Sea-Elephant found there by Pernetty, have been destroyed or driven away. The Sea-Leopards (*A. Hookeri*) were brought from the Antarctic Ocean as well as from the Falklands.

If that was the case, it may be the Falkland-Island Seal of Pennant and the *Phoca Hauvilli* that Cuvier described, as I formerly believed. There are no other Fur-Seals now

known of a dark-grey colour, with a whitish underside, that I have seen.

The *A. falklandicus* is very like the Fur-Seal from Australia (*A. cinereus*) in the length of the under-fur as compared with the length of the hairs, and also in the colour of the under-fur and hair; but the fur is much softer, and its general colour is much darker, both above and below.

M. de Buffon describes a small Eared Seal, which he calls a "second Phoque" (vol. xiii. p. 341, t. 43, where it is named "le petit Phoque"), which he was assured came from India, but very probably came from the Levant; and he considers it adult, because it has all its teeth. It is only one-fifth of the size of the Seal of the European seas (Hist. Nat. xiii. p. 344). He further speaks of it as "le petit Phoque noir des Indes et du Levant" (p. 345). It is evidently a young Eared Seal. The figure is probably from the skin, with the bones of the toes and jaws, presented to the cabinet by M. Mauduit (mentioned at p. 433. n. 1273), and said to have come from India.

The specimen Buffon figured, then being in the Paris Museum, was thus described by Cuvier (Oss. Foss. v. p. 220):—"Cet animal a deux pieds de long; ses oreilles sont grandes et pointues; son pelage est fourré, luisant, d'un brun noir très-foncé et a sa nuance blanchâtre. Le ventre seul est brun jaunâtre." The teeth show that it is young.

The figure and description of the *Petit Phoque* of Buffon have had the following names given to them:—

Little Seal by Pennant and Shaw.

Phoca pusilla, Schreber, Säugeth. 314.

Phoca parva, Bodd. Elench. 78.

Otaria pusilla, Desm. N. Dict.

Otaria Peronii, Desm. Mamm.

Fischer, in his 'Synopsis,' under *Phoca pusilla*, p. 252, gives the Cape of Good Hope and Rotteness Island, on the coast of Australia, as the habitat of the species.

The description of Cuvier much more nearly fits that of the young *Arctocephalus nigrescens* from the Falkland Islands. The fur of the young Cape Seal is dark, black above and below; the hairs are slender, and brown (not whitish) at the base; and the underside is not yellowish brown; so that it is very doubtful if it is the young of the Cape Seal.

Dr. Peters, believing Buffon's specimen to be a young Cape Seal, changed the name of *Delalandii* to *pusilla*.

There formerly existed in the Museum of the Royal Society an Eared Seal without any habitat; it is called the Long-necked Seal in Grew's 'Rarities,' p. 95, described and figured under

that name by Parsons in the Phil. Trans. xlvii. t. 6, and noticed in Pennant's 'Quadrupeds,' ii. p. 274. Dr. Shaw, in his 'Zoology,' i. p. 256, translated the name into *Phoca longicollis*, and copied Parsons's figure. The name and the form of the front feet are enough to show that it is an Eared Seal; for the neck of these animals is always long compared with the neck of the Earless Seals or *Phocidæ*. Fischer, in his 'Synopsis,' p. 240, overlooking this character and the description of the front feet, considers it the same as the Sea-Leopard of Weddell (*Phoca Weddellii*) from the Antarctic Ocean, an Earless Seal. Though the habitat is not given, there can be no doubt, when we consider the geographical distribution of the Eared Seal, that it must have been received either from the southern part of South America or from the Cape of Good Hope, as the animals of the Northern Pacific and of Australia were not known or brought to England in 1686. As no account of the colour of the fur is given, it is impossible to determine to which of the species inhabiting these countries it should be referred. It is most probably the Sea-Lion (*Otaria leonina*), as that is the animal which is most generally distributed and commonly brought to England. The sailors sometimes call it the "Long-necked Seal."

Dr. J. R. Forster, during his voyage with Cook in 1775, observed an Eared Seal at the Cape of Good Hope, which he called *Phoca ursina*, believing it to be the same he had previously observed in New Zealand. (See Descript. Animal. p. 315).

The sixth volume of the Supplement to Buffon's Hist. Nat. contains an account of the Sea-Bears of the Cape of Good Hope, communicated by M. de Pagès (vi. p. 343, 354, 357). He described the hairs of the young as blackish, becoming silver-grey at the tips as they increase in age.

M. Cuvier described an Eared Seal received by M. Delalande from the Cape, 3 feet 6 inches long. The fur is close, soft, woolly at the base, the tips annulated with grey and black, giving a general reddish grey-brown tone. The belly is paler, and the legs blackish. The whiskers are strong, simple, and black. (Oss. Foss. v. 220.) M. Delalande also sent the skeleton of a young animal and the head of an adult; the skull of the latter is figured by Cuvier (Oss. Foss. v. t. 18. f. 5).

These specimens were described as *Otaria Delalandii*, Cuvier, by M. F. Cuvier (Dict. Sc. Nat. xxxix. p. 423); and the skull of an aged animal was figured by me as that of *Arctocephalus Delalandii* in the 'Proceedings of the Zoological Society,' 1859, p. 107, t. 69; it is also described in my 'Catalogue of Seals and Whales in the British Museum,' p. 52. The species grows

to a much larger size than the specimen described by M. Cuvier. There are two well-grown stuffed specimens of it in the Collection of the British Museum, and there is very little to add to Cuvier's description above referred to.

Mr. Bartlett kindly sent to the British Museum for my examination a series of the skins of this Seal as they are sold by the fellmonger, on which I made the following notes:—

1. Adult male, with slight mane, called in the sale-catalogue "large-wig." Fur whitish, with a few intermixed black hairs; under-fur short, reddish.

2. Adult, without the mane, called in the sale-catalogue "middling." Fur reddish white, grizzled with scattered black hairs; underside of the body darker, reddish brown; under-fur short, reddish.

3. Young, about 18 inches long, called in the sale-catalogue "black pup," from the Cape of Good Hope. Fur black, polished, soft, smooth, without any grey tips, rather browner black beneath; under-fur brown, very sparse; hairs slender, polished, black, with very slender brown bases.

With these skins were two others, sold at the same time, and called "middling" Fur-Seals; but they are so different from all the others in the form of the hair as well as in its length, and they are also so nearly destitute of under-fur, except just on the crown of the head, that I am convinced they could not be dressed as Fur-Seals; and I believe they are a most distinct species, which I propose to call

Arctocephalus nivosus.

Fur very short, close-pressed, black, varied with close, small, often confluent, white spots; underside of neck with a few scattered white hairs; belly red brown (nearly bay); hairs short, thick, of one colour to the base; under-fur none, except a very few hairs on the crown of the head.

Hab. Cape of Good Hope. B.M.

Length of skin nearly 8 feet, but stretched and flattened.

Unfortunately these skins are without skulls; so I cannot decide to which subgenus they ought to be referred.

These and those previously mentioned have been transferred by Mr. Bartlett to the Museum Collection.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

January 30, 1868.—Lieut.-General Sabine, President, in the Chair.

“Remarks upon *Archæopteryx lithographica*.” By Prof. T. H. HUXLEY, LL.D., F.R.S.

The unique specimen of *Archæopteryx lithographica* (von Meyer) which at present adorns the collection of fossils in the British Museum, is undoubtedly one of the most interesting relics of the extinct fauna of long-past ages; and the correct interpretation of the fossil is of proportional importance. Hence I do not hesitate to trouble the Royal Society with the following remarks, which are, in part, intended to rectify certain errors which appear to me to be contained in the description of the fossil in the Philosophical Transactions for 1863*.

It is obviously impossible to compare the bones of one animal satisfactorily with those of another, unless it is clearly settled that such is the dorsal and such the ventral aspect of a vertebra, and that such a bone of the limb-arches, or limbs, belongs to the left, and such another to the right side.

Identical animals may seem to be quite different, if the bones of the same limbs are compared under the impression that they belong to opposite sides; and very different bones may appear to be similar, if those of opposite sides are placed in juxtaposition.

The following citations, and the remarks with which I accompany them, however, will show that these indispensable conditions of comparison have not been complied with in the memoir to which I refer.

1. “The moiety (Plate I.) containing the greater number of the petrified bones exhibits such proportion of the skeleton from the inferior or ventral aspect” (*l. c.* p. 34).

I propose to show, on the contrary, that the fossilized animal presents, in general, its dorsal aspect to the eye, though one of the most conspicuous bones may have been so twisted round as to exhibit its ventral face.

2. The demonstration that the bones of the *Archæopteryx* are thus wrongly interpreted, may be best commenced by showing that what is called “right femur (65), tibia (66), and bones of the foot (68, i, ii, iii, iv),” *l. c.* p. 35, are respectively the left femur, left tibia, and bones of the left foot.

That such is the case is very easily proved by the circumstance that (as is very properly pointed out in the memoir) the second toe of the foot in question is that which lies uppermost, while the plantar surface of the foot is turned outwards, and its dorsal aspect towards the vertebral column.

If the limb in question were, as the describer of the fossil sup-

* “On the *Archæopteryx* of Von Meyer, with a description of the Fossil Remains of a Long-tailed Species, from the Lithographic stone of Solenhofen.” — Professor Owen, F.R.S. &c.

poses, the right leg, it would obviously be impossible to place the foot in its present position, unless the numbers of the phalanges in its toes were the reverse of what is observed in Birds; that is to say, the uppermost toe, that which has three phalanges, must also be the outermost. Nevertheless the describer of the fossil justly lays great stress upon the fact that the toes have the same number of phalanges as in birds. As a matter of fact, this is quite true; but it would not be true if we were to assume with him that the limb in question is the right leg.

3. Certain parts of the fossil which lie upon the opposite side of the spine to the so-called "right leg" are named, at p. 34 of the memoir cited, "Portion of the left os innominatum, showing part of the ilium (62) and ischium (63), with the acetabulum (a)."

A full description of this mass of bone as "the left os innominatum, including the anterior two-thirds of the ilium, and the anterior half, or more, of the coalesced ischium," is given at p. 39; and at p. 40 I find, "The inferior or central* face [of the sacrum], as in the case of the slightly dislocated left innominatum, is towards the observer."

There is no doubt on any side, that the end of the bone in question which at present is directed forwards is its true anterior end, and that the edge which is turned towards the spinal column is the true dorsal edge. The question is, whether the face of the bone which is exposed is its outer (or dorsal) or its inner (or ventral) face. In the former case it must needs be a right ilium, in the latter a left ilium.

That it is the outer face of the bone which lies uppermost appears to me to be demonstrated—

(a) By the fact that the iliac margin of the acetabulum is prominent, and that the adjacent surface of this ilium rises to this margin. I am not aware that any vertebrate animal exists in which the acetabulum lies at the bottom of a funnel-shaped depression, such as would be the case in *Archæopteryx* if the bone in dispute were the left os innominatum seen from the inner side.

(b) By the fact that a small portion of what appears to be an innominate bone can be described in close relation with the proximal end of what has just been shown to be the left femur; while the right femur (called left in the memoir), though dislocated, is not very far from the bone under discussion.

(c) By the further consideration, that if this were not the right os innominatum, it would be as curiously unlike the corresponding bone of a bird in the form of its surface as it resembles it in all other respects.

4. The bone marked 51' is named "left scapula" (*l. c.* p. 34), and that marked 51 "right scapula" (*l. c.* p. 35); and a full description of these bones, as such, is given at pp. 36 and 37 of the memoir cited.

* "Central" in the original. The word appears to have been substituted by an error of the press for "ventral."

Nevertheless I venture to affirm that 51' is the right scapula and not the left ; for it will not be denied that the anterior or glenoidal end of the bone, as it now lies, is directed forwards, its posterior or vertebral end backwards, and its glenoidal articular surface outwards and forwards : it would be quite impossible to put a left scapula of similar construction into this position.

Further, the glenoidal end of this scapula remains in connexion with what is obviously the glenoidal (or humeral) end of the right coracoid (marked *c* in plate i.). The author of the memoir, indeed, gives a different interpretation of the osseous projection thus marked (*l. c. p. 37*) :—

“The prominence beyond the left scapula (Plate I. 51') suggested at first view the humeral end of the coracoid, but I believe it to be part of the humerus corresponding with the tuberosity on the ulnar side of the sessile semioval head, overarching the pneumatic foramen in the bird.”

And this view is pictorially embodied in the restoration of the humerus of *Archæopteryx* given in plate ii. fig. 1.

But a most distinct line of matrix separates the humerus from the prominence in question, in which may be seen, with great clearness, the glenoidal facet of the coracoid, as well as the excavation of the exterior surface of the bone which is characteristic of the glenoidal, or humeral, end of the coracoid in birds and pterodactyles.

I think, then, there can be no question that the parts marked 51' and *c* in Plate I. of the memoir cited are the right scapula and the glenoidal end of the right coracoid, and not, as the author affirms, the left scapula and a tuberosity of the humerus.

5. Even apart from the fact that the humerus marked 53' lies in almost undisturbed relation with the right pectoral arch, it is obviously a right humerus. On no other supposition can the relative position of the deltoid ridge and of the various contours of the bone be accounted for. Nevertheless this is called “proximal half of left humerus (53'), entire, and part of the distal half” at p. 34 of the memoir cited.

It is probably needless to pursue this part of the inquiry any further. As the so-called right leg turns out to be the left, the so-called left os innominatum the right, and the so-called left scapula and wing-bones to be those of the opposite side of the body, the necessity of a corresponding rectification for the other limb-bones needs no evidence.

6. As both the hind limbs and one-half of the pelvis have just such positions as they would readily assume if the hinder part of the animal's body lay upon its ventral face, it is highly improbable (to say the least) that the caudal and posterior trunk-vertebræ should have turned round so as to present their ventral aspect to the eye, as they do according to the memoir (*l. c. p. 44*).

But I apprehend that evidence can be found in the vertebræ themselves sufficient to prove that their dorsal and not their ventral faces are turned towards the eye. In several of the best-preserved of these vertebræ, in fact, (and plate i. imperfectly shows this,) the remains

of two small articular processes are distinctly visible at each end of the vertebra. The superior surface of each articular process is raised into a low longitudinal ridge; and the posterior pair of processes lie at the sides of a narrow, parallel-sided plate of bone, which projects beyond the posterior edge of the vertebra, and is received between the anterior articular processes of the vertebra which succeeds it. A low linear longitudinal elevation occupies the place of spinous process.

If my interpretation of these appearances is correct, it is clear that the caudal vertebræ (as was to be expected) turn their dorsal faces to the eye.

7. One important and extremely conspicuous bone, the furculum (if it be such), undoubtedly turns its ventral surface to the eye; and I cannot but suspect that it is the *bouleversement* of this bone which has led to that reversal of the proper nomenclature of the other bones which, could it be sustained, would leave *Archæopteryx* without a parallel in the vertebrate subkingdom.

When the specimen of *Archæopteryx* is once put into its right position, many points of its structure acquire an intelligibility which they lose to those who accept the interpretations given in the memoir. The so-called right foot, for example, which, as a right foot, is like nothing in nature, becomes strikingly ornithic as a left foot, from the backward direction of the hallux and the apparent ankylosis of the metatarsal bones. The distal ends of the second and third metatarsals appear to me, however, to be separated for a much greater distance, proportionately to the length of the metatarsus, than in any existing birds, except the Penguins.

The femur is more slender and more curved in proportion to its length than in any recent bird with which I am acquainted. The representation of the bone in fig. 1 of plate iii. is inaccurate, as may be seen by comparing it with that given in plate i.

The small size of the cnemial crest of the tibia is also very remarkable.

The right innominate bone is imperfectly represented in plate i. of the memoir cited. Its anterior end is not, as it there appears to be, abruptly truncated: there is an elevation in the region which would be occupied by the prominence against which the base of the great trochanter works, and which is so characteristic of birds. The greater part of the ischium is not represented; and the sacrosacral space certainly has not the form which it is represented to have. The references *o* to the "obturator foramen," and 63, to the "ischium" (*l. c.* p. 40), are unintelligible to me.

The ischium can be traced back for $\frac{3}{4}$ of an inch from the acetabulum; and so much of it as is preserved remains narrow throughout this extent, and is convex upwards, but concave downwards or towards the matrix.

The ventral edge of the ischium appears to be entire throughout this extent; but the posterior moiety of its dorsal edge is somewhat rough and angular. It is therefore very probable that the ischium

expanded behind the sacrosciatic notch and united with the ilium, as it very generally does in carinate birds. It is very desirable that this part of the skeleton of *Archæopteryx* should be figured again.

The scapula has a distinct clavicular process, as in carinate birds; and it seems to be pretty clear that the scapula had that twofold angulation upon the coracoid which is characteristic of the *Carinatae*.

The glenoidal end of the coracoid is unlike the corresponding part of that bone in any of the *Ratitæ*; but it is more like that of a Pterodactyle than that of any carinate bird which I have met with. It is less prominent (and the counterpart shows that this shortness is not the result of fracture) than in any recent bird, provided with a strong furculum, with which I am acquainted. In fact, in its form, and strength relatively to the shoulder-girdle, the so-called "furculum" appears to me to be the greatest osteological difficulty presented by *Archæopteryx*. I prefer waiting for the light which will be afforded by another specimen to the indulgence of any speculation regarding this bone; in the meanwhile, I by no means wish to deny that appearances are strongly in favour of the interpretation which has been put upon it.

In conclusion, I may remark that I am unaware of the existence of any "law of correlation" which will enable us to infer that the mouth of this animal was devoid of lips, and was a toothless beak. The soft tortoises (*Trionyx*) have fleshy lips as well as horny beaks; the *Chelonia* in general have horny beaks, though they possess no feathers to preen; and *Rhamphorhynchus* combined both beak and teeth, though it was equally devoid of feathers. If, when the head of *Archæopteryx* is discovered, its jaws contain teeth, it will not the more, to my mind, cease to be a bird, than turtles cease to be reptiles because they have beaks.

All birds have a tarso-metatarsus, a pelvis, and feathers, such, in principle, as those possessed by *Archæopteryx*. No known reptile, recent or fossil, combines these three characters, or presents feathers, or possesses a completely ornithic tarsometatarsus, or pelvis. *Compsognathus* comes nearest in the tarsal region, *Megalosaurus* and *Iguanodon* in the pelvis. But, so far as the specimen enables me to judge, I am disposed to think that, in many respects, *Archæopteryx* is more remote from the boundary-line between birds and reptiles than some living *Ratitæ* are.

MISCELLANEOUS.

Size of Fœtus of the Pilot Dolphin.

MR. EDWARD GERRARD, junior, extracted the fœtus from an adult female of *Globiocephalus wineval* that was thrown ashore at the Firth of Forth. The female was 12 feet, the fœtus 3 feet long. The head of the fœtus is very globular; and the beak is well marked, but very short.—J. F. GRAY.

Notice of a remarkable new Genus of Corals, probably typical of a new Family. By F. B. MEEK.

Among some fossils sent on for investigation by Professor Whitney, the State Geologist of California, from the Silurian rocks of Nevada*, there are a few specimens of a new genus of corals presenting such an extraordinary and interesting combination of characters that it is thought desirable to call attention to it here†.

The specimens of this fossil contained in the collection are slender, slightly flexuous, arched or nearly straight, and subcylindrical, excepting near the lower end, where they taper to a point, by which they were probably attached. They may have grown in tufts or groups; but all the specimens yet seen are single, and show no evidences of growing in contact.

To the unassisted eye, the external surface of these corallites (with the exception of obscure annular swellings and constrictions of growth and faintly marked linear septal costæ) seem to be nearly or quite smooth. When examined under a strong lens, however, it is seen to be beautifully punctate—the punctures being minute, of exactly uniform size, and arranged with mathematical regularity in quincunx, and so closely crowded that the little divisions between them are scarcely equal in breadth to the punctures themselves, and form, as it were, an extremely delicate kind of network. So remarkable is the appearance of this punctured outer wall, that the first question that suggests itself, on examining it under a magnifier, is, whether or not it may be merely an exceedingly delicate Polyzoon encrusting the whole surface. A clear examination, however (especially in carefully prepared transverse sections), shows that the punctures actually pass entirely through the wall, which is very thin, and that they are not due to the growth of a Polyzoon, nor to surface-ornamentation.

On grinding away this very thin punctured wall, the septa are seen immediately within to be stout, equal, straight, and very equidistant; but on grinding a little further in, they are observed to become very regularly waved laterally, *exactly like the septa in the foraminiferous genus Fusulina*. So striking is this resemblance, that it was not until after ascertaining from cross section that the fossil has not an involuted structure, that I could get rid of the suspicion that it might be a new type of Foraminifera allied to *Fusulina*, instead of an extraordinary coral.

By grinding still further in (to a depth of about 0.06 inch, in a specimen 0.34 inch in diameter), the lateral waving of the septa already mentioned is seen to be there suddenly and so strongly marked, that they connect laterally, in such a manner as to form a

* A notice of the discovery of Silurian rocks at this distant western locality has already been published by Prof. Whitney in the Proceedings of the Californian Academy of Sciences.

† Figures and descriptions of this and the other Silurian fossils from this locality will be given in the second volume of Prof. Whitney's report on the geology of California.

kind of complex inner wall between the great central cavity and the outer septate zone. This wall, however, does not completely isolate the septate outer zone from the central cavity, but is perforated by a series of round equal canals, very regularly placed one within each of the lateral curves of the septa, so that those on the opposite sides of each septum alternate with exact regularity, as do those of each of the two rows within each interseptal space. These canals have no similarity to the minute punctures of the outer wall, being greatly larger and very differently arranged. They do not pass *directly* through the inner wall, but are directed obliquely upward and inward, so that, as seen in transverse sections of the corallites, they present the appearance of a double row of vesicles cut across.

Both longitudinal and transverse sections show the large central cavity to be without any traces of septa or columella. From these sections I was likewise at first led to believe this central portion to be also an entirely open cavity or calice, the whole length of each corallite; but on sending specimens to Prof. Verrill, he called my attention to some obscure appearances of transverse plates in one of the specimens cut longitudinally, and requested me to cut others with the view of ascertaining whether or not these are plates. A longitudinal section of another specimen, however, when carefully polished, reveals no traces of proper transverse plates; but when examined by the aid of a strong magnifier, it shows the whole interior to be occupied by a dense vesicular tissue, the walls of the vesicles being of extreme tenuity. This structure is seen in the interseptal spaces of the outer zone, as well as in the central cavity within.

In regard to the affinities of so remarkable a type, it seems scarcely safe to express an opinion without a better series of specimens for study. Some of its internal characters, as suggested by Prof. Verrill, would seem to indicate remote affinities to the *Cyathophyllidæ*; but its peculiar perforated outer wall would, on the other hand, appear to remove it from the primary division of corals including that family.

I am therefore led to believe it a new genus, and most probably typical of a new family, in which opinion Prof. Verrill concurs with me. For this genus I would propose the name *Ethmophyllum*.

Among the specimens in the collection under examination, there are apparently two species of this fossil. That considered the type of the genus is larger and more robust than the other, and more conical in form, especially near its smaller end. None of the specimens seen are quite perfect at the larger extremity. One measures 0.37 inch at its imperfect larger end, and seems to have been $2\frac{1}{2}$ to 3 inches in length. In this there are sixty septa, while its outer septate zone is 0.07 inch wide. Another fragment, however, measures 1.20 inch in diameter at the larger end, and was probably 5 to 6 inches or more in length, with 112 septa at the larger end. This large fragment shows that the septate outer zone does not increase in thickness or breadth in proportion with the size of the corallites, since it is only 0.15 inch broad in this specimen, the in-

crease in thickness of this corallite being made up by the increased size of the non-septate interior. For this larger species I would propose the name *Ethmophyllum Whitneyi*, in honour of Prof. J. D. Whitney, to whom I am indebted for the use of the specimens.

Of the other species I have seen but a single specimen, which is imperfect at both extremities, about 2.15 inches in length, and only about 0.20 inch in diameter at the larger end, and 0.15 at the smaller, with some 24 to 28 septa. In addition to its much more slender form, it differs from the other species in having its septa so strongly waved laterally as almost to divide the interseptal spaces into cells, nearly to the outer wall. For this, if it should prove to be a distinct species, I would propose the name *Ethmophyllum gracile*.

The specimens were all obtained at Silver Peak, Nevada, and were discovered by Mr. Clayton.—*Silliman's American Journal*, January, 1868.

Note on the Polymorphism of the Anthozoa and the Structure of the Tubiporæ. By A. KÖLLIKER.

The polymorphism of individuals, so remarkable among the Acalephæ, has had nothing corresponding to it among the other Cœlenterata; it is therefore a very unexpected discovery that M. Kölliker has lately made, of a true polymorphism in various genera of Anthozoa Alcyonaria. This polymorphism consists in the existence, besides the large individuals capable of taking nourishment and furnished with generative organs, of other, smaller, asexual individuals, which appear essentially to preside over the introduction of sea-water into the organism, and then over its expulsion, and which are perhaps at the same time the seat of an excrementitious secretion. Like the others, these asexual individuals possess a body-cavity divided into chambers by eight septa, and a pyriform stomach with two orifices. On the other hand they are entirely destitute of tentacles; and instead of the eight ordinary mesenteric filaments there are only two, supported upon two consecutive septa. The cavity of the body of these individuals is always in communication with that of the sexual individuals; but the mode in which this communication is effected is liable to vary with the genera.

We may distinguish two types in the mode of distribution of the asexual individuals upon the polyparies. In the first they are distributed in great abundance over the whole polypigerous region of the polypary, among the sexual individuals. This is the case in certain Alcyonids which M. Kölliker refers to the genus *Sarcophyton*, and also in *Veretillum*, *Lituarina*, *Cavernularia*, and *Sarcobothrium*. In the second case the asexual individuals are restricted to certain perfectly definite places, which, however, are variable according to the genera. Thus in certain species of *Pteroeides* they occur on the lower surface of the pennate leaves of the region serving for attachment, in the form of a larger or smaller plate; in other species of the same genus they are also found at the apex of the polypary; in

the *Pennatulæ* the varicosities of the trunk correspond to the places where the asexual individuals are seated; *Funiculina quadrangularis* shows them arranged in longitudinal rows between the sexual individuals; lastly, the *Virgulariæ* always present behind each lamella, upon their trunk, a simple transverse row of asexual individuals.

It is probable that all the Pennatulidæ present a similar dimorphism; at least, in *Renilla* we see, between the fully developed polypes, rudimentary bodies which seem to be individuals of a different form. On the other hand, with the sole exception of the genus *Sarcophyton*, M. Kölliker has sought in vain for dimorphism in the Alcyonidæ and Gorgonidæ. It must not be forgotten, however, that there seem to exist some relations between the buds of the sexual and asexual individuals in the polymorphic polyparies; for, in *Veretillum* at least, the asexual individuals seem, under certain conditions, capable of being transformed into sexual individuals.

M. Kölliker has also been able to investigate a polypary of *Tubipora*, still enveloped by the soft parts, obtained from the Fiji archipelago. Notwithstanding the great resemblance of the polyparies of the *Tubiporæ* to those of the Madripores, the author considers that in their whole structure and development these polypes are Alcyonaria which must occupy a place by the side of the genus *Clavularia*. Both the tentacles and the body of the polypes of *Tubipora* contain spicules.—*Würzburger Zeitung*, January 4, 1868; abstract by E. Claparède in *Bibl. Univ.* February 15, 1868, *Bull. Sci.* p. 171.

On the Saliva and Salivary Organs of Dolium galea and other Mollusca. By MM. S. DE LUCA and P. PANCERI. (Note by E. CLAPARÈDE.)

Ten years ago M. Troschel made the unexpected discovery of the presence of a considerable quantity of free sulphuric acid in the saliva of a Gasteropod, namely *Dolium galea*. MM. de Luca and Panceri have lately resumed the investigation of this subject, and have confirmed, in their general features, the results obtained by their predecessor. They find the quantity of free anhydrous sulphuric acid varying from 3·3 to 3·42 per cent., a quantity which is even a little more than that ascertained by M. Troschel. On the other hand the Neapolitan naturalists have found no trace of free hydrochloric acid, whilst the analysis formerly made by Boedeker at the request of Troschel indicated 0·4 per cent. of this.

It was interesting to ascertain how far this phenomenon is isolated. MM. de Luca and Panceri have for this purpose investigated the saliva of various mollusca, and found free sulphuric acid in notable proportion in four species of *Tritonium*, in a *Cassia*, a *Cassidaria*, two *Muriceæ*, and an *Aplysia*. Moreover in all these mollusca, including the *Dolium*, these naturalists have seen a gas evolved from the salivary liquid at the moment of the rupture of the gland. This gas was found to be pure carbonic acid, and its volume in one case amounted to as much as 20·6 cubic centimetres from a gland of about 75 grammes in weight.

These different salivary liquids have the properties of not undergoing alteration spontaneously in contact with the air, and of preserving unaltered albuminoid substances immersed in them.

The part played by these acids, which are secreted in such considerable quantities, is still very obscure. The authors remark that, in the mollusca in question, the blood is still alkaline; they promise further investigations of the subject.—*Bibl. Univ.*, February 15, 1868, *Bull. Sci.* p. 170; abstract from *Rendiconto d. R. Accad. Sci. di Napoli*, August and September 1867.

On an Hermaphrodite Nemertian (Borlasia hermaphroditica) from St. Malo. By W. KEFERSTEIN.

Great importance was formerly attributed in zoology to the union of the two sexes in the same individual, or their separation in two distinct individuals; and quite recently a French naturalist has endeavoured to distribute the Invertebrata into classes, chiefly in accordance with this character.

It is, however, now certain that monœciousness and diœciousness have only a secondary value. Thus we know, for example, that both in the Annelida and in the Nematoda, which generally have the sexes separate, a certain number of hermaphrodite species are to be met with; we also know some diœcious Trematoda, in a group otherwise entirely hermaphrodite; and recently, in the group of hermaphrodite *Planaria*, we have become acquainted with a species in which the sexes are separated (*Planaria dioica* from St. Vaast).

Hence the discovery made by M. Keferstein at St. Malo of an hermaphrodite Nemertian is not particularly surprising; but in any case it is an important fact, since it is the first example of hermaphroditism in this group. In this animal, to which M. Keferstein gives the name of *Borlasia hermaphroditica*, the testes were found full of mature spermatozooids, and the ovaries of ovules in course of formation. The author having studied only a single individual, it might be suspected that the organs designated by him under the name of testes were seminal receptacles filled with semen; nevertheless M. Keferstein believes he has ascertained that this interpretation would be erroneous.

However this may be, the author asks whether the discovery of an hermaphrodite Nemertian would not serve to throw a little light upon the Nemertians in the perivisceral cavity of which well-developed living young have been found by M. Max Schultze, M. Claparède, and M. Keferstein himself.—*Göttinger Nachrichten*, January 15, 1868; abstract by E. Claparède in *Bibl. Univ.* February 15, 1868, *Bull. Sci.* p. 173.

Anatomical Investigation of some Blind Coleoptera.

By M. C. LESPÈS.

Many insects destitute of eyes have been described in the last few years, and among these the Coleoptera especially have attracted

attention. Some of them live in caves, others in the earth, and some are domesticated among the Ants.

The absence of the eye is not the character of a distinct family; several genera belonging to different families present the same anomaly. None of these insects have hitherto been made the subject of anatomical investigation; but I have examined the nervous system of five species, the only ones that I have been able to procure in sufficient number. Several of the others are so small that they cannot be dissected. These five species belong to four families of Coleoptera; three live in caves, namely, *Aphænops Leschenaultii* (Carabidæ), *Adelops pyrenæus*, and *Pholeuon Querilhaci* (Silphales); one lives with ants, namely *Claviger Duvalii* (Psclaphidæ); and the last is found deep in the earth, this is *Langelandia anophthalma* (Latridiidæ).

In all these insects the eye is entirely wanting. The abortion of this organ induces the disappearance of the optic nerve, and even that of a portion of the nervous centres; for the cerebroid ganglia, instead of forming a mass placed transversely in the head, have the form of two elongate-oval bodies placed nearly parallel to each other. This form resembles that of the cerebroid ganglia of some blind larvæ the perfect insects of which possess eyes.—*Comptes Rendus*, November 25, 1867, p. 890.

Action of the Induction-current upon Plants.

By C. BLONDEAU.

M. Blondeau has pursued his investigation of the effect of the induction-current upon the vegetable organism (see p. 33) by examining its action upon the fruit and seed.

Acting upon fruits the current hastens their maturity. Apples, pears, and peaches which had been subjected to the action of the current arrived at complete maturity when the other fruits of the same plant, which had not been operated upon, were still far from being ripe.

The most curious results were obtained by electrifying seeds before placing them in the ground. Seeds were rendered conductive by soaking them for some time in water, and then submitted for a few minutes to the action of the current. Peas, French beans, and wheat were experimented on. The electrified seeds always germinated sooner than those which had not been acted on by the current; the development of the plant was more rapid, and the stalks and leaves greener and more vigorous.

Some of the electrified French beans presented a very curious peculiarity; they germinated downwards, the gemmule and cotyledons remaining in the ground, and the root rising into the air. The author remarks upon this peculiarity, which he compares to the effect of the current upon the poles of a magnet, and indicates that the embryo may hence be assimilated to a little magnet, having its neutral line, and its two poles each charged with a peculiar fluid tending to cause its organs to grow towards the centre of the earth or towards the sky.—*Comptes Rendus*, November 4, 1867, pp. 762-763.

On the first Formation of the Body in the Vertebrata.

By Professor His.

Professor His, in continuing his researches upon the ovular development of the Vertebrata, has arrived at some results fitted to produce a considerable change in the theory of blastodermic lamellæ as modified by Remak. According to the author, the blastodermic lamellæ would seem to constitute only secondary formations, and even the median lamella cannot at any period be regarded as an anatomical whole.

M. His distinguishes, from the first, in the hen's egg submitted to incubation, two primitive blastodermic formations: at the expense of one are formed all the organs closely or distantly related to the nervous system—the central nervous system, the peripheral nerves, the epidermis, the glands, and the muscles, both striped and smooth; from the other originate the blood and the connective tissues. The former is what is generally denominated the *proligerous disk*; but M. His gives it the name of *archiblast* or *neuroblast*; the latter is the white vitellus, or the *parablast* or *hæmatoblast*, according to M. His.

The archiblast is derived from what Meckel von Hemsbach denominated the ovule properly so called—that is to say, the part of the egg which undergoes segmentation after fecundation. The parablast, on the contrary, is an adventitious formation, comparable to the cells of the granular tunic of the ovum in the Mammalia; and its constituent elements are similar in both the fecundated and unfecundated ovum.

In the fecundated but not incubated egg, M. His distinguishes the germinal disk and the white and yellow vitelli. The white vitellus forms a thin stratum surrounding the yellow one, and is prolonged beneath the germinal disk in the form of a cord to the centre of the egg. The germinal disk is a thin plate which rests upon the white vitellus, in the place where the ovule, properly so called, occurs in the unfecundated egg. After fecundation, this ovule, by segmentation, becomes converted into the germinal disk. Beneath this there is a cavity filled with liquid, the bottom of which is formed by the white vitellus. The peripheral part alone of the germinal disk rests immediately upon the white vitellus. Their line of union is what M. His names the *blastodermic circumvallation* (*Keimwall*). The part of the germinal disk beneath which the cavity is situated is the pellucid area; that which assists in forming the circumvallation is the opaque area. The author reverts to the opinion of MM. Schwann and Reichert, according to which the elements of the white vitellus are true nucleated cells. The cells of the germinal disk form at first a continuous layer—the superior blastodermic lamella. From the inner surface of this lamella start cords which anastomose and form a sort of network, but never, before incubation, produce the true inferior blastodermic lamella.

The first result of fecundation is the complete formation of the

inferior blastodermic lamella, which still remains for a time united to the superior lamella by filaments. Then the axial lamina of Remak is formed, in which M. His distinguishes three parts:—1, a layer detached from the superior blastodermic lamella; 2, a layer detached from the inferior lamella; and, 3, an axial cord of union between these two layers. The first two of these parts (*inferior and superior accessory laminae*) are characterized by vertical striæ. The third is designated by M. His the *axial cord*. These parts give origin to the medullary tube, the dorsal cord, the protovertebræ, and the cephalic and lateral plates. The first indication of the place where the descending aortæ will subsequently be situated appears in the form of lacunæ behind the rudiments of the protovertebræ. The situation of the heart is marked by a similar lacuna.

As the superior blastodermic lamella sends prolongations downwards into the pellucid area, it sends perfectly similar ones into the opaque area. But then these prolongations do not form, properly speaking, a continuous lamella, but they penetrate the subjacent stratum of white vitellus, to form in it a sort of network embracing in its meshes the elements of that vitellus. The tissue thus formed receives from the author the name of *circumvallatory tissue* (*Keim-wallgewebe*). Subsequently, in the central part of the opaque area, the superficial layer separates to form the vascular area, whilst the peripheric adherent portion forms the vitelline area.

In the interior of the circumvallatory tissue there now appears, according to the author, a complete system of lacunæ, which, speedily opening one into the other, cut off a thin superior layer. This sends off filiform prolongations both upwards and downwards. It is the *hamatogenous membrane*, formed of cells of the archiblast united into a network of which the meshes enclose bundles of cells of the white vitellus. These packets of cells are the starting-points of the formation of the blood-vessels: fusiform cells start from them to penetrate into the subjacent lacunæ and clothe them with a continuous endothelial layer; thence they enter the pellucid area, where they extend themselves in the lacunæ between the inferior accessory lamina and the inferior blastodermic lamella; finally, continuing their centripetal advance, they introduce themselves into the cardiac and aortic lacunæ mentioned above, where they arrange themselves in a coil, which merely applies itself to the walls of these lacunæ without becoming amalgamated with them. From these primitive vascular walls are subsequently developed all the rudiments of vessels, as also the mass from which are derived the connective and cartilaginous tissues, and in general all the conjunctive tissues. We may therefore say that, from a genetic point of view, all the conjunctive substances may be assimilated to the adventitious tunics of the vessels.—*Archiv für mikrosk. Anat.* Band ii. p. 513; *Bibl. Univ.* August 25, 1867, *Bull. Sci.* pp. 330–332.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 4. APRIL 1868.

XXIX.—*On Lithodomous Annelids.* By E. RAY LANKESTER,
Junior Student of Christ Church, Oxford.

[Plate XI.]

Two years since, my friend Mr. Charles Stewart, then residing at Plymouth, told me of certain Annelids which were in the habit of perforating limestone rock in that neighbourhood, and which he had found, when removed from their excavations and placed on blue litmus-paper, to give a strongly acid reaction. Soon after this, I received, by his kindness, specimens of this Annelid, which proved to be a *Sabella*, described by De Quatrefages as *Sabella saxicava*, and abounding on certain limestone coasts. The species is a small one, forming a dirty-looking leathery tube, about one inch and a half in length. Of this, one inch is buried in a perfectly cylindrical and straight excavation in the limestone, to the walls of which gallery the tube closely fits; the other half inch of tube projects freely from the surface of the rock (Pl. XI. fig. 4).

Having had my attention called to the subject, I remembered certain perforated stones and pebbles abundant on the south coast of the Isle of Wight, which seemed to me to be very possibly the work of an Annelid; and when there, a year since, I searched carefully for specimens. Below the Lower Greensand cliffs near Luccomb Chine there are but few large calcareous boulders on the shore, though there are many of indurated sandstones, of varying hardness and colour. Not a fragment of the sandstones, though some were very soft, exhibited a single worm-perforation; but wherever a boulder consisting largely of carbonate of lime lay between tide-marks, it was more or less excavated by minute passages; and these in many cases were so numerous that it was obvious that the author of these "riddlings" must play an important part in the destruction and solution of such masses of carbonate of

lime (figs. 1 & 2). On breaking off fragments of these stones (often so hard as to defy a heavy geological hammer), the passages were found to extend in many cases to the depth of an inch, and in some cases to two inches and a half, the breadth of the cavity varying proportionately. The excavations in this case were not cylindrical, as with *Sabella*, but in transverse section presented a keyhole- or figure-of-eight outline (fig. 3). As seen in the drawing, they do not terminate abruptly, but appear to be formed by the bending-round of a single cylindrical gallery. Within these galleries, and coiled round so that the head and the tail both point to the aperture, many specimens of the worm which made them were found (figs. 5, 6). The worm does not lie in immediate contact with the stone, but the interior of the gallery is lined and its substance impregnated with a viscid secretion derived from the worm's body. The partition between the two parallel passages of the gallery is often formed solely of this material. Boulders are not unfrequently found which have been entirely deserted by their occupants, or from which these have passed away by death and decay; and in those cases the animal matter which lines the excavated passages is very easily seen, and sometimes may be peeled off as a black carbonaceous film.

Having the case of *Sabella saxicava* in mind, I was fully prepared to ascribe to a chemical action the perforation of the hard limestone boulders by the *Leucodore*; for to that genus of Johnston (*Polydora* of Bosc) the worm proved to belong. In this view I received a quite unexpected confirmation on subsequently visiting White Cliff Bay, where the shore is covered with huge masses of chalk rounded by the sea's washing and overgrown with Algæ. A very large proportion of these blocks were perforated on the surface, just as the limestone boulders further west; and yet it would be difficult to find two rocks differing more in density and molecular structure than chalk and those limestone boulders. Their only resemblance was in their *chemical composition*. It was noticed that in this chalk bay the perforations were by no means so closely disposed: there was abundance of material, and therefore no cause for crowding. Specimens of the worms from the chalk-perforations were obtained in great abundance, and proved identical with those from the limestone, whilst the galleries were identical in every respect. Subsequently to this, I received specimens of limestone from Felixstow, on the coast of Suffolk, where the whole shore is clay, masses of soft clay being exposed at low tide, overgrown with weed and abounding with life. Not a single *Leucodore*-perforation is to be found in this clay, though *Pholades* and *Euniceæ* are abundant in it. Here and there in

the clay is a septarian nodule (carbonate of lime); and this presents the characteristic keyhole apertures and double galleries which the *Leucodore* makes in the chalk and limestone boulders of the Isle of Wight.

These two cases of the boring of stones by Annelids are the only ones which at present have come under my notice. The case of *Sabella saxicava* is described by De Quatrefages; but of the boring of *Leucodore* I have seen no clear description or figure. Thousands of persons and hundreds of naturalists must have seen these borings; yet none have given more than a brief allusion to the matter. M. de Quatrefages alludes to the fact in a general way in speaking of the family of "Leucodoriens;" he says, "Some species evidently bore very hard calcareous rocks," and mentions fragments of rock "entirely worm-eaten." Mr. Templeton, in a paper on various marine animals, published in Loudon's Magazine in 1837, has given the most definite allusion to the boring of *Leucodore*. He gives a rough outline figure of the gallery, without describing its form, and speaks of the worm as *Spio calcarea*: the *Spio* of Fabricius was very probably a "Leucodorien." Mr. Spence Bate, in a paper on marine boring animals, alludes to certain Annelids, by which he may very possibly mean to indicate both *Sabella* and *Leucodore*. Mr. Gwyn Jeffreys also alludes to borings by Annelids in the same anonymous manner. The most remarkable allusion, however, to lithodomous Annelids, and one which shows how very indefinite the knowledge of this matter has been, is that of Dr. Bowerbank, quoted by Mr. Albany Hancock in his recent paper on *Cliona*. Dr. Bowerbank attributes the passages in shells which are inhabited by *Cliona* to a "lithodomous Annelid." He does not venture to say that he has seen this animal, but speaks of it as a very likely being to play such a part. Mr. Hancock, in replying to this, did not adduce the most complete refutation of this theory (viz. that no such lithodomous Annelid was known), but urged that the form of the passages was not such as an Annelid would be likely to produce. The two above-described cases of perforation are, I believe, the only ones at present observed; and certainly, in both, the form of the perforation is very unlike that of any *Cliona*.

2. Having thus described what is the form of the perforations made by the two lithodomous Annelids, the question arises as to how these perforations are made, and in what way, if any, the structure of the worm is related to such a habit. With regard to *Sabella saxicava*, in the first place, there is no hard structure in this species which is not possessed by other non-lithodomous species; and no one can maintain that the

chitinous setæ would be of much avail against hard limestone. Mr. George Busk, at the meeting of the British Association at Dundee, suggested in discussion that the perforation was possibly effected, both in this case and in that of *Leucodore* which I then described, by means of sand rubbed by the worm against the rock or introduced into its gallery when once begun. This he had witnessed in *Pholas*. The objection to such a view in the case of either of the Annelids is, that they do not possess the necessary power of lateral movement, or any *point d'appui*, also that they only bore carbonate of lime; and, further, it is impossible to guess how an attack could be commenced on a stone in such a manner. We are reduced to the theory that the gallery of *Sabella* is formed by the constant apposition of the tail of the Annelid to the carbonate of lime. The tail has been proved to be acid, and is therefore a perfectly sufficient cause.

The boring *Leucodore* is represented in Pl. XI. fig. 7; and it will be seen that, whilst the ordinary bristles are situate on each somite, the fifth alone possesses very thick dark-coloured setæ, more or less blunt at the point (fig. 9). We cannot suppose that these have any effect in perforating limestone, since they are merely chitine, and, moreover, are present in species of *Leucodore* which do not perforate, and which live by hundreds in the silt filling cracks of rocks &c., or construct for themselves rough and fragile tubes. At the same time they may very possibly be efficient in excavating loose material. They are undoubtedly homologous with the dark bristles present in the anterior region of *Chaetopterus*, and perhaps are only rudimentary organs—Nature's certificate of a long pedigree. The sand-theory fails in the case of *Leucodore* for the same reason as in that of *Sabella*. In fact no mechanical explanation of the perforation will account for a chemical selection of material. In every case of *Leucodore*-perforation to which I have alluded, and with dozens of fragments from various stones, often presenting the most different appearances, and looking more like sandstone than limestone, I have tested for the presence of carbonate of lime, and have invariably found it in large quantity; all the fragments which I submitted to analysis were rapidly disintegrated under the action of weak acetic acid. Another fact in favour of chemical action is the extremely clean and sharp character of the galleries, both in *Sabella* and *Leucodore*.

My friend Dr. M'Intosh was the only observer at Dundee who expressed a belief that these Annelids perforate rocks other than carbonate of lime. He said that he had seen aluminous shale so bored; but I think he had other excava-

tions in mind, such as Annelids will make in the semi-solid silt filling cracks in shale, or else that he has since seen reason to change his opinion; for he has not produced any such specimen of shale, although then challenged to do so. I submit that the opinion as to aluminous shale, unsupported by any chemical test or specimen, and confessedly only casually noticed, should not be of any weight in the balance against the facts as to the exclusive erosion of limestone which are above recorded.

Supposing, then, the agency in *Leucodore* to be a chemical one, has any acid been observed? It has: specimens of *Leucodore*, placed on litmus-paper, give a strong acid reaction, besides which the constant evolution of carbonic acid in the respiratory process, and its efficiency as a solvent of carbonate of lime, are well known. At the base of each parapodium in *Leucodore* is a little clear sac containing clear vesicles: its function and homology are doubtful (fig. 8); it may possibly secrete an acid fluid. But it seems much more probable that the erosion of the limestone, as a rule, is due to the evolution of carbonic acid. At the same time, these sacs (which exist also in the arenicolous species) may secrete sulphuric acid, as MM. Panceri and De Luca have lately observed in the salivary gland of *Dolium* and other mollusks. All chemists know well the powerful solvent effect of water, charged with carbonic acid, on limestone; but some zoologists seem unable to realize it. The objection to the action of carbonic acid has been made that it would continue to dissolve after the gallery was of sufficient size, and that *Serpula* and Mollusca would by it dissolve their own shells. There is a very simple answer to this, admitting of experimental proof: it is, that the viscid secretion which the Annelid or mollusk can exude affords a complete protection to any surface from further erosion by the acid. One argument in favour of chemical action in cases of boring generally, which seems to me to have some force, is that in all cases *the same surface* which deposits a shell, bone, or other such structure, can also reabsorb it. Now in *Serpula* we have a dense calcareous shell deposited by the surface of the body; why in other cases should not a similar mass of carbonate of lime be absorbed, or excavated, by that surface, as in *Leucodore*? In Mollusks we know that the shell may be deposited and reabsorbed; and in Vertebrates the absorption and deposition of bone goes on at the same surface. The case of *Pholas* boring gneiss must by no means be held to have put chemical action out of court in all cases of perforation; and whilst, in the cases of *Sabella* and *Leucodore*, I believe the greatest effect must be attributed to

such an action, and an auxiliary, but decidedly feeble, power to the setæ, there are many cases of molluscous excavation also in which chemical erosion has a large share in the result.

3. A few words remain to be said as to the specific title and distinction of the lithodomous *Leucodore*. In the first place, it appears, from the remarks of Mr. Alexander Agassiz, lately published in this Magazine, that *Leucodore* of Johnston is truly a synonym of *Polydora* of Bosc. Claparède and De Quatrefages have both described species as belonging to the genus *Leucodore*, which do not possess the characteristic modification of the fifth segment, and are really species of *Nerine* of Johnston. If this be so, Johnston's name *Leucodore* will have to fall. At the same time, it seems probable that both generic terms will be wanted; and I will not undertake to say how each shall be limited. The boring species does not differ obviously from *Leucodore ciliata*. I have not been able to make a comparison of specimens; but it seems probable that they differ only in habit. Nevertheless, on account of this habit, it may be well to give Templeton's title (which has precedence) of "*calcareæ*" to the boring form, which may be designated *Polydora* (*Leucodore*, Johnst.) *calcareæ*. The same form of seta (fig. 10), the same copious ciliation of the branchial cirri which arch over the dorsum, the same remarkable anal cup or sucker (?), and the same form of head, with two tentacles which readily drop off, and a producible prostomium, characterize both *P. ciliata* and *P. calcareæ*. It is quite possible that more careful examination may disclose marked specific differences, not only between these, but also between the various individuals boring limestone, chalk, &c.

XXX.—*On the Occurrence of the Genus Ptilograpsus in Britain; with Notes on the Ludlow Graptolites.* By HENRY ALLEYNE NICHOLSON, D.Sc., M.B., F.G.S.

THE genus *Ptilograpsus* was originally described by Hall as occurring in the Quebec group in Canada; and two species have been differentiated by him, viz. *P. plumosus* and *P. Geinitzianus* (see 'Graptolites of the Quebec Group,' pp. 189, 140, pl. 21. figs. 1–8). In the Skiddaw Slates, our English equivalent of the Quebec group, no traces of this genus have hitherto been found; nor does it appear to occur in the Upper Llandeilo rocks of the south of Scotland, or in the Coniston Flags in the north of England—both especially rich in forms of Graptolites. Recently, however, by the kindness of Mr. Lightbody and Mr. Marston, of Ludlow, I have been furnished

with specimens of a new species of *Ptilograpsus*, which I purpose to describe briefly under the name of *P. anglicus*. The generic characters of *Ptilograpsus* consist in the possession of a branching plant-like frond, the branches and branchlets plumose. The pinnules spring alternately from opposite sides of both the primary and secondary divisions of the frond, and are celluliferous on one side only. The base of the frond is not known, the probability, however, being that the organism was fixed.

As pointed out by Hall, *Ptilograpsus* closely resembles the modern *Plumularia*; and, as far as its characters are yet known, there is perhaps no really important point of difference. Certainly the resemblance to such forms as *Plumularia cristata* and *P. myriophyllum*, the first especially, is most striking, and must be more than merely mimetic. Like *Dictyonema*, *Dendrograpsus*, and *Callograpsus* (all genuine Graptolites), *Ptilograpsus* was probably permanently attached, though in none of these genera has the commencement of the "hydrocaulus" been yet detected. Another point in which *Ptilograpsus* agrees with the above-mentioned genera and differs from the great majority of Graptolites is in the apparent absence of the "solid axis"*, the individual branchlets consisting simply of cellules or "hydrothecæ" springing from a common canal or "coenosarc." By this absence of the solid axis, of all Graptolitic structures the most anomalous, *Ptilograpsus* manifestly approaches very closely to the Sertularian type, though not more closely, perhaps, than do *Callograpsus* and *Dendrograpsus*. *Dictyonema*, again, though certainly belonging to the same natural subgroup of the Graptolitidæ as the above three genera, has a fresh structure superadded in the shape of transverse dissepiments connecting together the different branches which constitute the frond.

Ptilograpsus anglicus, spec. nov.

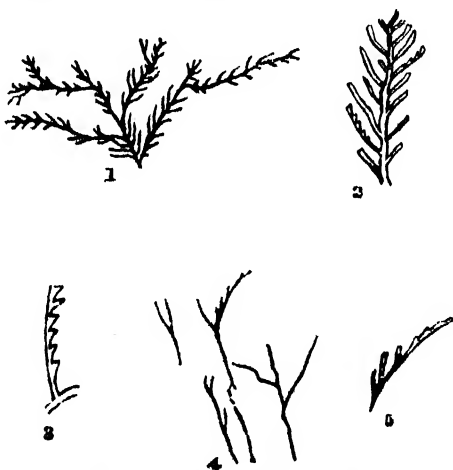
Spec. char. Frond slender and branching, all the branches, large and small, being provided with pinnulæ, which spring alternately from opposite sides, and bear angular cellules on one face. Pinnulæ from twenty to twenty-eight in an inch, their length varying from two to three twentieths of an inch.

* The "solid axis" has usually been supposed to be an essential element in the structure of every Graptolite, the genus *Retiolites* alone excepted. In common with the great majority of writers on the subject, this belief was shared by myself, and I did not believe that even the above-mentioned exception would be found to hold good. Recent investigations, however, into this particular point have led me to the opinion that the axis is not so constantly present as has been generally thought, that it is certainly absent in the genera I have spoken of, and probably absent in others.

The cellules are from three to six on a pinnule; when well exhibited, they are angular, projecting, and closely resembling the cellules in some forms of *Graptolites Nilssoni*, Barr. The test is corneous, and there are no traces of any solid axis.

The entire frond is not known to me; but I have seen fragments of nearly two inches in length. Whether this species is absolutely distinct from that of the Quebec group, termed by Hall *P. plumosus*, it is difficult to say, in the absence of the cellules of the latter. It is, however, highly improbable that the species should have survived through a period of time so vast as this would imply. Our species, too, is of a much more slender and graceful habit than is the case with either of the American species, whilst the branching is more diffuse and the pinnulæ are shorter.

Loc. In a greenish-grey mudstone, of Lower Ludlow age, from Bow Bridge, near Ludlow.



Ptilograpsus anglicus, spec. nov.

1. A small portion of a frond, natural size.
2. A single branchlet, enlarged.
3. A single pinnule, enlarged, to show the cellules.
4. Branched Graptolite (*Ptilograpsus*?) from the Lower Ludlow rocks of Bow Bridge, near Ludlow, nat. size.
5. A portion of the same, enlarged, showing pinnulæ and cellules(?).

In the same bed with *Ptilograpsus anglicus* there occurs a branching fossil, in the same state of preservation as the former, and almost certainly Graptolitic, though I have failed to detect cellules except in one instance, and then not with certainty. I possess, however, but a single specimen, which I

owe to the kindness of Mr. Lightbody, of Ludlow. Its mode of branching is much more discrete than that of *P. anglicus*; and the branches, which arise alternately from opposite sides, are not provided with pinnulæ or cellules near their origins. Whether true pinnulæ are developed on the terminal portions of the branches, or not, is doubtful; but both pinnulæ and cellules appear to be present on one of the branches of my specimen (see fig. 5). If this is really the case, then the fossil would form a new species of *Ptilograpsus*; but it is just possible that it may be referable to *Dendrograpsus*, a genus equally ancient with the former, and equally unknown in beds of such a late age.

Besides the above, the Ludlow rocks in the neighbourhood of Ludlow contain at least three other species of Graptolites. One of these is the familiar *Graptolites priodon* of Bronn—the *G. ludensis* of the 'Silurian System.' The second is certainly distinct from *G. priodon*, though none of the specimens at present in my possession are in a state of sufficiently good preservation to enable me to come to an accurate determination. It is identical with a Graptolite which occurs in the "sheer-bate" beds at the top of the Coniston Flags of the north of England; and it seems almost, if not quite, undistinguishable from one of the forms of *G. colonus*, Barr. (See Barrande, *Graptolites de Bohème*, pl. 2. fig. 5; Geinitz, *Graptolithen*, pl. 2. fig. 34.) The third presents a considerable resemblance to some varieties of *G. Nilssoni*, and also to the younger forms of *G. sagittarius*, Linn.; but it is remarkable for the peculiarity that the cellules are on the concave (instead of the convex) side of the stipe. This condition is probably of specific value; but it seems better to refrain from making a new species until, by the examination of an extensive suite of specimens, the peculiarity in question is proved to be constantly and persistently present. Whether specifically distinct or not, the existence in the Ludlow rocks of a form so closely allied to the above-mentioned Lower-Silurian species, along with a genus hitherto only known from the base of the Lower Llandeilo series, is a highly suggestive and noteworthy fact. For one thing, it seems to be exceedingly probable that the Graptolitidæ will ultimately be found to be not so exclusively Silurian as has generally been supposed. Hall has taken the first step in this direction by the discovery in America of species of *Dictyonema* in the Old Red Sandstone (Upper Helderberg and Hamilton groups); and subsequent researches will very probably show the coexistence with these of other genera of which the Graptolitic nature is more universally acknowledged.

XXXI.—*On the Geographical Distribution of the Balænidæ or Right Whales.* By Dr. J. E. GRAY, F.R.S., V.P.Z.S., F.L.S., &c.

PROF. VAN BENEDEN has read a paper to the Royal Belgian Academy on the geographical distribution of *Les Baleines*, which is published in the first number of the 'Bulletin' for 1868, accompanied by a map. He acknowledges only five species of Right Whales, having the following geographical distribution :—

1. *B. mysticetus*. The Arctic Ocean on both sides of Greenland, and on the coast of Siberia to the Sea of Okhotsk.

2. *B. biscayensis*. The North Atlantic, from latitude 65° to 45° , and a belt across the Atlantic to the coast of the United States, from lat. 45° to 50° .

3. *B. japonica*. A band across the North Pacific from lat. 60° to 45° on the west coast of America and 45° to 30° on the coast of Japan.

4. *B. australis*. A belt across the South Atlantic from lat. 25° to 30° on the west coast of Africa and lat. 35° to 50° on the coast of South America.

5. *B. antipodarum*. In a similar belt across the South Pacific from the west coast of South America, in lat. 45° , to New Zealand.

Thus it will be seen that M. Van Beneden supposes that Right Whales inhabit belts across all the seas except the Indian Ocean. This exception is extraordinary, as Capt. Maury's chart shows that Right Whales are comparatively abundant in a belt between latitude 30° and 50° from the Cape of Good Hope to Australia. It is in this belt that *Balæna marginata* and *B. australiensis* are most probably found; but M. Van Beneden ignores the existence of these species.

Mr. Blyth also mentions a species of Right Whale, under the name of *B. indica*, founded on some bones in the Museum of the Asiatic Society of Bengal, which he says inhabits "the Bay of Bengal, Arabian Sea, and occasionally enters the Persian Gulf." But this must be a mistake, as these places are situated in the torrid zone, which is to these animals, as Capt. Maury justly observes, "forbidden ground; and it is as physically impossible for them to cross the equator as it would be to cross a sea of flame. In short, these researches show that there is a belt, of from two to three thousand miles in breadth and reaching from one side of the ocean to the other, in which the Right Whale is never found." (Maury, *Whale-Charts*, p. 233.)

The distribution of the species here propounded by M. Van Beneden is simply founded on a theory: he does not give any authority for the range of any of the species; and I believe that no materials exist for verifying the distribution proposed.

M. Van Beneden compares his map with those of Captain Maury; but these maps were formed from actual observation made by the masters of whalers; and they only undertake to show where Sperm and Right Whales have been observed, without attempting to define which species of Right Whale inhabited the respective districts; indeed Capt. Maury seems only to allow two Right Whales—one inhabiting the northern, and the other the southern hemisphere.

I should be sorry to say that the species, or at least some of them, may not have the range that M. Van Beneden has assigned to them, because I have no material for such a statement; but many facts we do know militate against the theory. At the same time I do not think that science is profited by the propounding of such a map without more material, as it may mislead some zoologists to believe that authority for the distribution of the species may exist, and thus prevent them from studying the subject; and Cuvier has well observed that "when imagination is left at liberty in scientific pursuits, the result is almost always error and confusion."

As a proof of the want of authority for the distribution here given, I may observe:—

1. That I am not aware that any bones or other remains (even a piece of whalebone) have ever been received of a Right Whale or *Balæna* caught on the coast of Siberia; so we cannot decide whether it is the *B. mysticetus* of the coast of Greenland that inhabits the seas of Siberia.

2. We only know the Right Whale found on the Siberian coast from a wooden model made by some Aleutians, though Capt. Maury's chart shows they are abundant in those seas. Some whalers seem to think they are like those in Baffin's Bay, and others that they are very different from them, remarking that "it is not the easiest thing in the world to distinguish the different kinds of whales, even to those who have been in the whaling business; and a ship must be brought close by a whale to tell for certain his kind" (Whale-Charts, p. 255).

Capt. Roy, who believes "the Whales of Behring's Straits and Baffin's Bay are the same," observes, "they differ very much from the Kamtschatka or North-west Whale, or the Right Whale of the China seas," showing that in his opinion the Right Whale of the coast of Siberia and Kamtschatka is

different from, and not, as M. Van Beneden supposes, the same as *B. mysticetus*.

3. *Balæna biscayensis* is only known from the skeleton of a young specimen taken at St. Sebastian, in the Bay of Biscay, now in the Museum at Copenhagen. Mr. Flower informs me that this skeleton belongs to my genus *Cuvierius*, which has brittle whalebone, with a large coarse fringe (which easily splits into strips), and a bifid first rib. It is very doubtful if this is the Whale found on the coast of North America, as it ought to be according to M. Van Beneden's chart. The only reliable account of the Whale of that coast is to be found in Dudley's paper in the 'Philosophical Transactions' (xxxiii. p. 258), who says the "Scrag-Whale" (*B. gibbosa*, Erxleben) has white whalebone, "that won't split," which seems to show that it was a true *Balæna*, which is separated from *Eubalæna* on account of the toughness, flexibility, and unsplitability of its whalebone; and, indeed, Dudley says the Scrag-Whale "is nearest the Right Whale (*B. mysticetus*) in figure and quantity of oil." This does not prove that *B. biscayensis* does not inhabit the coast of North America; but it goes far to show that a species very like *B. mysticetus* does; and M. Van Beneden does not note this fact, though he places without doubt the geographical range of *B. biscayensis* as extending to that country, for which there is not a particle of evidence. It may be observed that Capt. Maury's 'Whale-Charts' do not offer any confirmation of Prof. Van Beneden's distribution of this species of Right Whale: they are very rare in the North Atlantic and off the coast of North America; a few have been observed in the midchannel between Morocco and North America, but they were probably animals accidentally carried out of their course.

Professor E. D. Cope, of Haverford College, United States, described the "Black Whale" of the whalers of the east coast of the United States, from a nearly complete skeleton in the Museum of the Academy of Natural Sciences in Philadelphia, under the name of *Balæna (Eubalæna) cisarctica* (Journ. Acad. Nat. Science, Philad. 1865). This may be the same as *B. nodosa*; but it is certainly not the *Balæna (Hunterius) biscayensis*; for it has "fourteen pairs of ribs, the anterior single-headed," and therefore is a true *Eubalæna*. Prof. Cope says, "Individuals are occasionally cast ashore eastward, and some are known to enter New-York harbour. They were formerly abundant about the mouth of the Delaware: a letter of William Penn, dated 1683, states that eleven were taken that year about the capes. Five specimens are stated to have been seen in the Delaware River since that time; and ten of great size are recorded to have been found on the

coast of Maryland. Three have come under my notice—one taken opposite this city three years ago, one cast ashore in Rehoboth Bay, Del., and one in Molzach Bay, Va."

B. japonica.—I am not aware if any bones or other remains of this species are to be found in any European museum, except the whalebone that is imported under the name of "northwest-coast whalebone," meaning thereby that of the whales of the north-west coast of America. I first brought this whalebone under the notice of zoologists in the 'Zoology of the Erebus and Terror.' There is no doubt that an extensive whale-fishery is carried on by the Japanese, from the works they have published on the subject; and it is very probable that the whalebone imported as north-west whalebone may be the same as that obtained by the Japanese; but we have no means of determining this point, as I have never been able to procure any whalebone imported from Japan. This is probably what the whalers call the Kamtschatka or North-west Whale, which they say is very different from the whale of Behring's Straits and Baffin's Bay (Whale-Charts, p. 255).

B. australis.—This species is only known from two skeletons brought from the Cape of Good Hope by M. Delalande, now in Paris, and some bones, sent from the Cape, in the British Museum; but we have no material to determine what is the species of whale that inhabits the vicinity of the Falkland Islands and the east coast of South America.

It is supposed that the whalebone sold in London as the "South-Sea whalebone" is the baleen of this species; but I am informed that that kind of whalebone is collected by the ships that fish in the great southern oceans; and there certainly is found a second most distinct species of Right Whale near the Cape of Good Hope. A very fine skull of an adult and a nearly complete skeleton of a young individual, both obtained from the Cape of Good Hope by Dr. Horstock, are contained in the Leyden Museum. These are briefly described by Schlegel, in his 'Abhandlungen aus dem Gebiete der Zoologie,' part 1, p. 137, as *B. mysticetus australis*; and I have named them *Hunterius Temminckii* (Cat. of Seals and Whales in British Museum, p. 98). M. Van Beneden entirely overlooks this species in his distribution of the Whales in his chart.

Balæna antipodarum is only known to zoologists from a drawing by Dieffenbach and a skeleton in the Paris Museum which was obtained in New Zealand. Dieffenbach gives some account of the migration of this species, but he gives no authority for extending its geographical distribution to the west coast of South America. I have never seen any whalebone said to have come from New Zealand, though Dieffenbach says

the strand of Tory Channel is strewed with the baleen and the bones of this Whale.

Capt. Maury's Whale-Charts show that Right Whales of some species have been observed in almost all parts of the the South Sea, from the south of the Cape of Good Hope to the coast of Van Diemen's Land (that is, a belt of sea from latitude 35° to 50°), and even a few in latitude 55° . I have no means of determining if the Right Whale inhabiting this district is *B. australis*, *B. Temminckii*, *B. australiensis*, or a peculiar species not yet determined. Prof. Van Beneden, in his chart, does not mention any Right Whales being found in the district.

I think that we must wait for more material before we can attempt a sketch of the geographical distribution of these animals in which any reliance can be placed. The only information we possess may be thus summed up:—

Capt. Maury's Whale-Charts show that Right Whales are found in almost all seas, from the poles to within 35 or 30 degrees of latitude on each side of the equator. An experienced whaler observes that "Right Whales are as seldom seen in that belt as Sperm-Whales are found out of it." Right Whales, that were comparatively common in the temperate part of the North Atlantic, are now very rare: they were probably greatly destroyed by the whalers who formerly fished there, as they do now in the Southern Sea and North Pacific; and the great traffic, and the bay being all inhabited, prevent these animals having the requisite privacy for replenishing their race. Maury's maps show how few are now found in this part of the ocean; and only a single specimen of the *B. biscayensis* is in any collection; and the Scrag-Whale (*B. nodosa*) of the coast of North America has not been observed since Dudley's time.

1. We only know, from the examination of specimens, that *Balæna mysticetus* is found in Greenland.

2. *Balæna biscayensis*, on the coast of Spain.

3. *Balæna australis* and, 4, *B. Temminckii* at the Cape of Good Hope.

5. *Balæna antipodarum*, New Zealand.

6. *Balæna australiensis* and, 7, *B. marginata* on the shores of Australia; the latter only known from some blades of its whalebone.

8. *Balæna japonica*, of Japan, which is probably the whale that yields the baleen sold as north-west whalebone. No other part of this Whale is known to exist in any museum.

9. *Balæna nodosa*, the Scrag-Whale of Dudley, inhabits the coast of North America; but, unfortunately, no specimen

or part of a specimen of this species is known to exist in any museum.

10. *Balæna cisarctica*, the Black Whale of the whalers of the east coast of the United States of America, may be the same as *B. nodosa*. There is a skeleton in the Museum of the Academy of Sciences, Philadelphia; and it is probably a skeleton of this species that "is exposed to all weathers on the roof of the Museum of Comparative Zoology at Cambridge, Massachusetts." (See Agassiz, Rep. 1864-65.)

How far the species indicated range beyond the habitats whence they were received is yet to be discovered and recorded. No doubt their range is influenced by many local circumstances (peculiarities in the currents, and disposition of the food) that are not easily observed or understood. For example, Capt. Maury observes:—"The Sperm-Whale, according to the result of this chart, appears never to double the Cape of Good Hope. It doubles Cape Horn. Since this fish delights in warm water, shall we not expect to find off Cape Horn an under-current of warm water heavier with its salt?" (Maury, Whale-Charts, p. 267.)

XXXII.—On a Variety of *Spongilla Meyeni* from the River Exe, Devonshire. By H. J. CARTER, F.R.S. &c.

Spongilla Meyeni (*Ephydatia*, Gray)*, var. *Parfitti*, Carter.

Massive, flat, more or less lobed, sessile, spreading. Colour greenish, yellowish. Texture friable. Structure reticulate. Seed-like bodies spheroidal, accumulated towards the base, largest about $\frac{1}{16}$ inch in diameter. Spicules of skeleton fusiform, slightly arched, acerate, abruptly pointed, largest $\frac{1}{16}$ inch long; of two kinds, smooth and spinous; one-third of the largest thickly set with short vertical spines throughout, except towards the points. Spicules of seed-like body birotulate, $\frac{1}{16}$ inch long, more or less sparsely scattered throughout the wall of the seed-like body, wherein they are arranged vertically, with the outer rotule projecting a little beyond the amorphous (siliceous?) substance that chiefly keeps the whole together; rotules deeply dentate, stellate, wider in diameter than the spicular shaft which unites them; shaft cylindrical, the same size throughout.

Hab. River Exe, Devonshire; Salmon-pool Weir, near Exeter. On a beam of wood over which the water falls. In masses attaining a maximum length of 1 foot, with $1\frac{1}{4}$ inch thickness (Mr. Parfitt).

* Proc. Zool. Soc. Lond. May 9, 1867, p. 550.

Obs. This *Spongilla* chiefly differs from *Sp. Meyeni* of Bombay in the decidedly spinous character of one-third of its largest spicules, while about the same proportion in the Bombay species can be only termed "incipiently spinous." The excess in size of the elementary parts generally of the Bombay species over those of the variety in the river Exe amounts to nothing, specifically considered.

But there is a much more decided difference between var. *Parfitti* and the birotulate English species termed *Sp. fluviatilis*, which also grows in the river Exe, inasmuch as the spicules of the skeleton in the latter are *all* smooth, the shaft of the birotules, somewhat *constricted* in the centre, approaching to hour-glass shape, with the margin *only* of the rotules minutely dentate, almost fringed*.

I am indebted to my intelligent friend, the able naturalist of Exeter, Mr. E. Parfitt, for having brought to my notice the existence, in the river Exe, of the variety and species of *Spongilla* above mentioned, where this gentleman found them some time since; and, he having kindly submitted them (in the dry state, with his own notes of what they were when alive) for my examination and publication, I cannot do better than dedicate the variety to him.

The indistinct colour of var. *Parfitti* may perhaps be attributed to the filtering position in which it grows, viz. on the beam of the weir over which the Exe falls at the Salmon-pool, if not also the more spinous state of its spicules generally; while the position of *Sp. fluviatilis*, taken from the Canal and parts of the Exe just above, where Mr. Parfitt found it incrusting the stems and leaves of *Anacharis* and on hard substances respectively, presents not only the usual fawn-colour of Sponges in general, but also a less spinous state of the spicules—perhaps from a less agitated state of the water in which it grows.

I still adhere to the term "seed-like body," instead of adopting that of "ovary," used by Dr. Bowerbank; for where, literally, we cannot yet make "head or tail" of an organism, it certainly is premature to designate any part of it by a term which is essentially connected with the *true* process of generation. Moreover I have already pointed out the identity in structure and composition of the seed-like body of *Sp. Carteri* with the winter-egg of the Bryozoa†; and I am pleased to find just now, by chance, that Meyen, long before this, had

* See also Dr. Bowerbank's figures and descriptions, Proc. Zool. Soc. Lond. Nov. 24, 1838; and Ray Soc. publ.

† Annals, 1859, vol. iii. p. 331.

stated, "they [the seed-like bodies] are similar to what are denominated the winter-eggs of Polypes"*.

I have also lately observed that the seed-like bodies in *Sp. Carteri* (which *Spongilla* grows rapidly round the stems of herbaceous plants during the six months that the upper parts of the freshwater tanks in Bombay are filled) are developed towards the periphery, that *Sp. plumosa* develops its seed-like bodies throughout all parts of its structure almost equally, while the three other Bombay species develop theirs respectively chiefly towards the base or first-formed parts.

In Prof. James-Clark's paper entitled "*Spongiæ ciliatæ* as *Infusoria flagellata*," now being republished in the 'Annals,' the author—after having most carefully examined *Leucosolenia (Grantia) botryoides*, Bowerbank, in connexion with a number of flagellate infusoria, both new and old in description—states his "conviction that the true ciliated *Spongiæ* are not Rhizopoda in any sense whatever, nor even closely related to them, but are genuine compound *flagellate Protozoa*."

Thus a flagellate infusorium would have to be considered the animal expression of *Grantia*; and if it can also be shown that these flagellate infusoria can reproduce their sponges respectively, directly or indirectly, by the true process of generation, and that all the sponge-cells which take in food, both ciliated and unciliated, receive it through an oral orifice, and not directly through any part of their bodies, then, so far, the Sponges can be disconnected from the Rhizopoda, and, I expect, generally will have to be regarded in the light in which the sagacious Professor of Natural History in the Agricultural College of Pennsylvania views the *Spongiæ ciliatæ*.

Still, if this be shown, I cannot yet see to what extent it could disassociate the Spongiadæ from the Rhizopoda, which evidently possess a like power of polymorphism.

But Prof. Clark's paper is far too able to justify a hasty conclusion or cursory criticism in any respect; and therefore this is not the time or place for me to add more than that it appears to possess extraordinary merit, which will be realized the more it is studied by the practical microscopist, who at the same time feels sensible of the duty he is performing towards the public in directing their attention to that end of the scale of organized beings concerning which we are still so profoundly ignorant.

P.S. Mr. Parfitt adds that *Spongilla fluviatilis* is plentiful

* Johnston, Brit. Sponges, footnote, p. 154 : 1842.

in the Exe and in the canal near Exeter, throughout the summer months; but, by attaching itself to plants which die down in the autumn, the specimens are all swept away by the winter floods.

XXXIII.—On the Spongiæ ciliatæ as Infusoria flagellata; or Observations on the Structure, Animality, and Relationship of *Leucosolenia botryoides*, Bowerbank. By H. JAMES-CLARK, A.B., B.S., Professor of Natural History in the Agricultural College of Pennsylvania.

[Continued from p. 215.]

§ 12. *Astasia trichophora*, Clap. Pl. VI. figs. 45, 46.

The transition from the mononematous *Monas*, *Codosiga*, *Leucosolenia*, &c. to those heteronematous Flagellata which possess at the same time a probosciform and a gubernaciform flagellum is most aptly exemplified by that curious mimetic combination of *Amœba* and *Anisonema* known as *Astasia trichophora*, Clap. (*Trachelius trichophorus*, Ehr.). At first sight it appears to be capable of all the abrupt retrogressive motions and short turnings of an *Anisonema* (figs. 65–69), without being endowed with a similar means of locomotion. One is not long, however, in discovering the homologue of the trail (*fl^a*) or rudder (*gubernaculum*) of the latter in the posterior abdominal, triangular prolongation (fig. 45, *fl^a*) of the body of the former. That this is the true interpretation of the prolongation is warranted not only by the use to which it is put, as a sort of *point d'appui* during the amœboid retroversions of the body, but also by its persistent form whilst the animal is contorted into a shapeless writhing mass. In the midst of the paucity of distinctive topography, we are also furnished by this organ, if I may so call it, with a basis of ready discrimination between the practically ventral and dorsal sides of the body; for, although it may not lie strictly in the central line of progress during reptation (nor could we expect to find it there upon being referred to its homological relation to the asymmetrically attached *gubernaculum* of *Anisonema*), it none the less belongs to the reptant side of the animal, and, as it were, controls its motions and acts as a keel, upon which the posterior end of the body vibrates and reels from side to side. Finally, in reference to this point, it may be added that this species does not swim, properly speaking, nor has it the character of the revolving natant forms, such as Dujardin separated from the *Astasia* of Ehrenberg and described under the name of *Peranema*.

For the sake of accumulating and multiplying diagnostic characters that shall serve us hereafter as discriminative points in determining the classificatory relations of Flagellata, it is most desirable that every critical study of one of these forms should be carefully recorded, even to the minutest details. On this account, therefore, and particularly in the present connexion, notwithstanding that this species is so frequently met with, and apparently so well known, it will not be out of place here to describe it anew, especially as some of the features presented for the consideration of naturalists are not in accordance with the interpretation put upon them by previous observers.

The *body* of this animalcule is colourless, but frequently has a slight yellowish or reddish tinge, which is derived by diffusion from the granular contents of the interior. The only legitimate colour present lies in the very faint red eye-spot (*s*). The form is variable, from elongate-ovate to cylindrical, with a gentle taper at the anterior third into a narrow truncate-emarginate head. Posteriorly the dorsal region is rounded; but on the ventral face a broad triangular prolongation (*f*²), already spoken of as the homologue of the *gubernaculum* of the reptant Heteronemata, extends backward beyond the outline of the *dorsum*. The exact relation of this prolongation to the axis of the body is not to be determined beyond a doubt, because of the constantly shifting attitude of the animal: at one moment the *gubernaculum* (*f*²) is on the left, and then at the next instant it appears on the right of the mesial line, or follows for awhile between these two points, according as the body keels over more or less from one side to the other or balances itself in a median position. It appears most frequently, however, to be unilateral.

The amoeboid contortions (fig. 46) of the body have already been mentioned; but I would add that this is only a resemblance, a mere suggestion, if one may use the term, of the mode of locomotion of *Amœba*; for it is not, as in the latter, an actual *flowing out* of a glairy mass into protean reptant processes, but an exceedingly variable *puckering*, and always accompanied by a longitudinal contraction of the body, the one being evidently necessary to the other. If I may carry out the niceness of distinction further, I should say that, whilst *Amœba* is contractile and plastic, *Astasia* is retractile and flexible.

The *flagellum* (*f*) also, by its subterminal attachment to the head, carries out the typical plan of the reptant Heteronemata. It is based strictly on the ventral side of the front, descending from the latter with such an abrupt turn forward

that it appears, without close observation, to be a mere tapering prolongation of this region. Yet it is neither related to the body in the latter sense, nor an extension of it from any point of view, but is as strictly an appendage as any form of vibratile cilia*, and alike as incapable of contraction. It is so stout and thick that one need not be surprised to find Ehrenberg, in the absence of a knowledge of the structure of this animalcule, mistaking the scarcely tapering *flagellum* for the frontal prolongation of a *Trachelius*. Usually it is about half as long again as the body; but that of very large animals often greatly exceeds this proportion. Its mode of action, as a propulsive organ, is not like that most frequently exhibited by the *flagella* of the truly natant Flagellata; for whilst in the latter case the vibrations pass along the whole length of the *cilium*, in the former they are confined to its distal end; and, moreover, they seem to be different in character, since, instead of simply undulating in a more or less restricted plane, the *flagellum* twirls at the tip rather after the manner of a revolving helix.

This method of progression is singularly modified by a rhombic meniscoid species of *Cyclidium*, Duj. (non Ehr.), whose *flagellum* during reptation projects (from a deeply sub-terminal point of the convex side of the body) without flexure almost to its tip, and then simply bends with frequent and vigorous strokes in the form of a hook, which it applies sideways against the surface over which the creature is passing, and drags it after it, tilted over on one of its flanks, in a hitching sidelong manner.

As a tactile organ, and for the purposes of prehension, the *flagellum* appears, by its great flexibility and vigorous action, to be eminently capable. Feeling about it with all the apparent expectation of finally meeting with something, the animalcule keeps its proboscis in a constant quiver, lashing it backward and forward in the meanwhile, or thrusting it along its flanks and then abruptly withdrawing it, very much after the manner of a *Lacrymaria*. When a particle of food is brought near the mouth (*m*), it is, as it were, coaxed into it by the light pulsations of the *flagellum*, apparently assisted by the movements of the buccal margin.

The *eye-spot* (*s*), so called, naturally comes under considera-

* As my views in regard to the relation of vibratile cilia to underlying cells may not be fully understood in this allusion, I would refer to my published opinion on this subject, in a note appended to some remarks upon *Actinophrys*, in the 'Proceedings of the Boston Society of Natural History' for September 1863, p. 283, and republished in the 'Annals and Magazine of Natural History' for November 1864.

tion in connexion with the tactile organ. It is a very minute circular body, apparently about as broad as the diameter of the *flagellum*, which lies a short distance behind the end of the head and just in front of the mouth (*m*). Frequently, from its excessive faintness and light-red colour, it appears to be absent; but, under careful scrutiny, it may always be detected. The tendency which prevails to undervalue the importance of this body, because it is present in an apparently similar position in the zoospores of *Algæ*, no doubt hinders our advancement in the knowledge of its true character and function. Whether it is an organ of vision of any grade, or even a sensorial centre of any kind, can only be brought within the range of probability. Its constant presence demands attention, and should excite inquiry on that ground alone; but when, moreover, we find it in a position which corresponds to that in which the chief sensorial centres are usually situated, no mere resemblance to something else should divert us into a train of fancies about the homologies of the red oil-globules of the zoospores of *Algæ*, whilst the main point at issue is left in obscurity.

If we cannot add anything further that is positive in regard to this organ, it will be well at least to attract attention to it in relation to its homologue in other Flagellata. In *Phacus pleuronectes*, Duj., it is not a uniform red spot, but seems to be divided into two regions, one of which is lunate in shape and of a bright red colour, and projects forward from the upper side of the other like an appendage; whilst the main part is more deeply seated in the dorsum, and consists of a colourless, but quite conspicuous, irregularly circular disk, about as broad as the contractile vesicle, which it partially overlies. In this case one might, with a fair show of reasonableness, suggest that the red portion alone is the true eye-spot, and that the colourless disk is a sensorial centre, not only for the former, but also for the flagellum, which arises close to it, on the ventral side. When we recall instances of the presence of a similar disk, which is unaccompanied by a red spot, in certain species of uniflagellate natant Flagellata (*Peranema*?, Duj.), and mark how long it is persistent after the body has fallen to pieces for the lack of fresh water, one cannot but feel that its superior consistency is a fair warrant for the belief that it is at least an important organ, and that, seeing the very faint colour of that of *Astasia trichophora*, the absence of all tint does not necessarily exclude it from the category of visual organs. On the other hand, it might be justly questioned whether even the deepest-coloured spots are at all sensitive to light; and the only answer would be that analogy renders it highly probable that they are.

The *mouth* (*m*) is a very marked feature when contrasted with that of other Flagellifers. It is usually to be observed in a closed state (fig. 46, *m*), when it may be recognized as a short, dark, sharply defined double line trending lengthwise with the body, and situated on the ventral side, a short distance behind the base of the *flagellum*, and just in front of the contractile vesicle. When open, it has a more or less broad oblong shape, and is more conspicuous than when closed. During the introception of food, it is quite active; but whether for the purpose of mastication, or merely to manœuvre the incoming particles, cannot be said positively, although it is probably with the latter design. The peculiar knobbed, parti-coloured aspect of the body is due to the almost invariably present large, highly refracting red and yellow granules in the general cavity.

The *contractile vesicle* (*cv*) is situated just behind the mouth, but near the dorsal side of the body. At full diastole it is globular, and its diameter is one-third of the breadth of the region in which it is situated. The systole is abrupt, and appears to be complete; and the diastole is slow, seeming to occupy all of the intervening time between the systoles. The rate of systole was not ascertained with sufficient accuracy to be recorded; but I should judge it to be not more than four or five times a minute.

The *reproductive organ* is probably represented by a very large, light, oval mass (*n*) which nearly fills the middle of the body. It has a decided outline, and, with the exception of a rather large central nucleiform body, its contents are homogeneous.

§ 13. ANISONEMA.

Anisonema concavum, nov. sp. Pl. VII. figs. 65-69.

Among all the heteronematous gubernaculifers, *Anisonema* ----- the highest degree of differentiation in its flagella (*f*, *f*²); for whilst in *Heteromita* and *Heteronema* these organs are comparatively more like each other, and arise from a nearly common point, as in the *Homoionemata*, in the former genus they exhibit a greater diversity of character, and also originate from more widely separated regions. These are particularly observable in the species before us now, and are certainly more valuable diagnostic characters than the presence of an uncontractile integument, by which to distinguish it from its congeners. The habitat of this animalcule is among tangled masses of confervoid *Algæ* in ponds and ditches, where decaying substances are most abundant. Upon these it moves with a more or less uneven pace, at one time gliding over a smooth

surface with scarcely a perceptible effort, and at another progressing with a laborious hitching gait, and lashing its *gubernaculum* (f^2) about, and swinging its body from side to side, with frequent jerks, in its efforts to pass over some obstacle.

The *body* is colourless and enclosed in an uncontractile, smooth integument. It has an asymmetrically ovate shape, rounded behind, and rapidly narrowed anteriorly into an oblique, truncate, conical front. Dorsally it is convex (figs. 67, 68); but ventrally, *i. e.* on the reptant side, it is concave on the right and in the middle, and so strongly incurved on the left that its sharp edge (t) reaches nearly to the median line. Beneath this inrolled border the enclosed space (fig. 68, t^1) projects into the left side like a longitudinal covered way. In front it is very deep, but from that point going backward it narrows gradually, and finally, with the inrolled edge, fades out at the posterior third of the body.

The *two flagella* (f, f^2) are as widely diverse in character and function as any two similar organs in the whole group of Protozoa. The anterior one (f) is, strictly speaking, the prehensile organ, as well as the main propulsory agent. It is quite delicate, and tapers gradually, from its subterminal base within the longitudinal covered way, to an extremely fine tip. In point of length it varies from one-half to two-thirds longer than the body. It is always carried in an extended position in front, and vibrates very actively, especially during reptation.

The posterior flagellar organ, or *gubernaculum* (f^2), is from three to four times the length of the body, and arises far from the front, in the deepest part of the covered way (fig. 68, t^1), and immediately beneath the contractile vesicle (cv). It is therefore attached quite near to the left margin of the body, and between the anterior and middle thirds. Its base, which is applied very obliquely to its point of attachment, is quite broad; but it narrows rapidly into a uniformly but scarcely tapering lash, which always projects forward more or less, and then curves backward and extends to a long distance behind. During reptation over smooth surfaces, it lies along the abdominal median line, and trails behind in long gentle undulations. Although it never vibrates, it frequently lashes about, and applies itself against obstacles on the right and left, or even in front, and acts as a prop upon which the body is thrown to one side or the other, according to varying circumstances. That it is contractile would seem incontestable upon observing the sudden jerk with which it sometimes draws the body back toward its distal end; but I am pretty well convinced, from a careful study of this movement, that, although this organ may be to a slight degree *resilient*, it is not

truly contractile, but rather *flexible*, and exhibits its muscular power by bending itself into coils or zigzags. Occasionally specimens are met with which have an additional pair of flagella (fig. 69, β^2), of a more delicate kind, attached near the others. That these originate as a preliminary step to fissi-gemination, although that phenomenon was not witnessed in this case, there can be scarcely a doubt, inasmuch as it accords perfectly with what has been observed in *Anthophysa* (p. 213).

The *mouth* has not been demonstrated to a certainty, by actually seeing food pass into it; but an approximative determination was reached by observing particles of matter, which were brought down by the prehensile *flagellum* (β), pass into the body somewhere near the front, and apparently within the compass of the covered way.

The *anus* (figs. 65, 66, a) was adjudged to be at the posterior end of the animal, by noticing, in a couple of instances only, a clear, more or less irregular, rounded mass in this region, and its final disappearance while under observation; but the substance was so transparent that it was not possible to decide positively whether it made its exit upon the dorsal or the ventral side.

The *contractile vesicle* (cv) is a comparatively large organ, with a rounded contour when in full diastole, and quite faint and inconspicuous. It lies above the base of the *gubernaculum* (β^2), the expanded base of the latter appearing at times to form a part of it, and by its movements (causing an alternation in light and shade) tends to mislead one into the belief that systole is very irregular. A careful adjustment of the lens, however, reveals the true pulsation, and shows that the systole has a very slow rate.

§ 14. HETEROMASTIX, Jas.-Clk.*

Heteromastix proteiformis, Jas.-Clk. Pl. VII. figs. 70-74.

I shall not describe this infusorian in the same systematic manner that has been adopted in treating of previous genera, because I do not know much about its internal organization; but in order that the direct alliance of the Flagellata with the Ciliata may be illustrated in this memoir in its strongest light, and inasmuch as *Heteromastix* is by far the best example of such a transition between the two above-mentioned orders, I shall take the liberty of quoting what I have already published in regard to it in another place†.

"Here is an infusorian (figs. 70-74), from fresh water,

* *ἑτερος*, dissimilar; *μίστιξ*, a lash. This genus was originally described in my published volume of Lowell Lectures, 'Mind in Nature,' p. 146, fig. 88.

† See note *.

which, although it has a pretty strong resemblance to *Euglena*, heightened by the presence of a red eye-spot (*s*), will be found upon investigation to possess some additional and decidedly different characters. In the first place, it has two vibrating lashes (*fl*, *fl*²), which differ remarkably among themselves both in position and character. One of them is always carried in front, like a sort of proboscis (*fl*); and in fact it seems to have the office of such an organ, like that of an elephant, to feel and to take hold of objects. I must confess that I was struck with astonishment at the apparent intelligence with which the infusorian extended, and twisted, and turned, and felt about with this extraordinary organ. Never did an elephant seem to use his trunk with more thoughtfulness. With like control did the animal also use the other lash (*fl*²), always keeping it turned back along the body, so that it formed a kind of moveable keel when the little creature glided along in its watery element, or was used to sway it from side to side, or oftentimes to raise it up on its tail by forming a prop, as we see it in this other figure (fig. 73).

"The motory or propelling power, on the other hand, is restricted, at least in the greatest measure, to another kind of vibratile cilia. These are very short, and are crowded together in great numbers (*cl*) in a broad furrow or depression (*f*) which extends over half the length of the body, along its inferior middle line. When the body is turned over, and the anterior end retracted and swelled out sideways, the furrow (fig. 73, *f*) becomes quite conspicuous, and the extent of the group of minor cilia (*cl*) is easily ascertained. They are very minute, and in constant motion, propelling the body backward and forward, up and down, to the right or left, according as it is steered by the trailing lash (*fl*²) which extends along its length. Thus it is that, although similar in form, a diversity of functions is laid upon these three kinds of cilia that amounts to the most marked specialization, through the simplest means—in fact so simple that the eye cannot detect them in any form besides that of proportion and position, and certainly not in the intimate structure of these bodies. The whole body, too, possesses a flexibility and extensibility scarcely inferior to its cilia: at one moment it is darting through the water, sharp as a lance at both ends; and at the next it is as round as a ball, or worming its way through tortuous passages with every possible degree of flexure short of actually tying itself into a knot."

It would be difficult to say now whether *Heteromastix* belongs to the Flagellata rather than to the Ciliata, or *vice versa*. The structure, position, and peculiar mode of action of its fla-

gella recall *Anisonema* (§ 13) most vividly to mind; but, on the other hand, the group of cilia (*cl*) in the obliquely longitudinal furrow (*f*) in close proximity to, and evidently acting more or less as allies with, the flagella (*f*, *f*²), find their parallel in the "proboscis-like lash" (fig. 75, *f*) and vestibular cilia (*cl*) in the oblique buccal furrow of *Pleuronema* (§ 16) and *Dysteria* (§ 15). How closely allied the two latter are to the former is not the immediate question here; it is, are they related at all? We think there can be no hesitation in replying in the affirmative; but in order that the reader may have the proof before his eyes, I think it will not be out of place, in this memoir, to introduce some of the undoubted Ciliata which possess at the same time organs that are as truly flagellate in character as are the flagella of *Anisonema*, *Astasia*, &c. The genus *Dysteria* shall be our first example.

§ 15. DYSTERIA, Huxley.

Dysteria prorafrons, Jas.-Clk.* Pl. VII. figs. 77, 78.

This species "is an infusorian between two leaves or flexible shells (*v*, *v*¹) of unequal width, which are united by a sort of hinge along the left border, and gaping to a more than equal extent along the right side, where the upper one (*v*) far overhangs the other (*v*¹, *bk*) throughout the whole length of its free edge. The broader or dorsal shell (*v*) is convex towards the eye, and the whole organization lies within its concavity, whilst the narrower one (*bk*, *v*¹) is flat, simply covering the body, and as a natural consequence does not include any part of it. The open space between them is endowed with a row of closely set, large vibratile cilia (*cl*), which differ in size according to their position, those in front being by far the longest, and those along the side scarcely more than half as long; and, in addition, there is one (*f*) which, from its great size, has more of the character of a proboscis or prehensory flagellum, and is attached nearly at the extreme anterior border of the row (*cl*).

"It is not an easy matter in this case to determine how much of the one-sided, cilia-bordered furrow corresponds to the disk or vestibule of *Epistylis*, *Stentor*, *Paramecium*, or *Pleuronema*; nor does it affect the question of the degree of obliquity of the conformation of this animal, so long as we see that, whatever it may be, either wholly or in part a vestibule, it is at least extremely oblique, and that it is not possible to view it from any point but that the body appears asymmetrical in relation to it.

* See 'Mind in Nature,' *ut sup.* p. 171, fig. 100.

"The most striking peculiarity of this creature is its habit of swinging around on a pivot (f^2), which consists of an ovate or lancet-shaped appendage, of considerable dimensions, that projects from near the posterior end of the body, and in the line of the row of cilia. The pivot possesses perfect flexibility at its base, so that the animal can move over a considerable distance backward and forward without disturbing the point. Most of the time it keeps the flat side down when gyrating around its place of attachment; but now and then it turns upon its right edge, and performs its eccentric rotations about the appendage. This is the habit which, as I said before, has impressed some observers with its similarity to the Rotifera. In connexion with this, too, it happens that the creature possesses a pair of jaw-like or, rather, pincer-like bodies (m^1), which lie near the entrance to the mouth, and occasionally open and shut like a pair of forceps, just as similar bodies known as the jaws of Rotifers do, whilst food is passing between them. Excepting the passage between these jaws, there is not the least trace of an intestine, or of any definite cavity devoted to digestion. The food occupies the whole length and breadth of the body, under the same circumstances as are observable in *Paramecium*, *Pleuronema*, *Stentor*, &c.

"The contractile vesicles are two (cv, cv) quite small globular bodies, one of which is situated just to the right of the jaws (m^1), and the other close to the base of the pivot (f^2); and, although they contract very slowly (not oftener than once in four or five minutes), they evince every characteristic, in action and physiognomy, of true infusorian pulsating vesicles. The large colourless reproductive organ (n) singularly exemplifies in itself the one-sidedness of the animal, by its conformation to the shape of the body. One side of it is convex, and, like the rest of the organization, projects into the concavity of the larger shell, whilst the other face is flat and, as it were, moulded upon the plane shell. It forms a very conspicuous object just to the left of the jaws, and might easily be mistaken at first glance for a contractile vesicle, especially as the true representatives of that organ are so very inconspicuous both in regard to their size and actions.

"Now in all the organization of this animal there is nothing which is not strictly infusorian in character. The jaw-like bodies (m^1) are not confined to this alone; for there are quite a number of others which possess a similar apparatus at or near the mouth. *Chilodon* has a complete circle of straight rods around the mouth. As for the pivot (f^2), it is nothing but a kind of stem, such as exists on a larger scale in *Stentor*, or is more peculiarly specialized in the pedestals of *Epistylis*, *Zootham-*

nium, or *Podophrya*; and, as counter to what we see in these last, I would state that there are certain of the Vorticellians, closely related to *Epistylis*, which have no stem whatever, and swim about as freely as *Dysteria*."

§ 16. PLEURONEMA, Duj.

*Pleuronema instabile**, Jas.-Clk. Pl. VII. figs. 75, 76.

This infusorian bears such a strong resemblance to *Heteromastix* (§ 14) in some of its external features, that it seems as if it might more properly have succeeded the latter in the illustration of my subject; but mere resemblances do not always indicate relationship: and in the case of *Pleuronema*, in particular, this is most true; for it is decidedly a far more highly organized animalcule than *Dysteria*, as we shall see by what I shall now quote from an already published description †:—

"What I wish now to show in the *Pleuronema* is the triple, or, I might say, even the quadruple diversity of the vibrating cilia, or, in other words, a quadruple specialization of one type of organs, by their manifold offices ranking their possessors above those of their class which attain to a less degree of complexity in this respect. The most prominent of these cilia are those (fig. 75, *cl*¹) which are arranged in longitudinal rows over nearly the whole extent of the body, and which most frequently are seen in a quiet state, projecting far out from the surface, like so many fine rigid bristles. In fact the motions of this animal are so lightning-like in rapidity, that I have never seen this form of cilia except when the body was in a quiet state; and therefore I judge that, as they do not move then, they are the principal organs of locomotion. There is on the right side a group of much more heavily built cilia (*cl*), which project from the oblique furrow in which the mouth (*m*) is set. They are more particularly devoted to producing currents in which the particles of food may be brought to the mouth.

"We see, also, projecting from the forward end of the oblique furrow, and near the anterior edge of the mouth (*m*), one of those proboscis-like lashes (*fl*) [*a flagellum*] which are so characteristic of the lower ciliate [*flagellate*] infusoria; but yet it would not seem to have the same office as in the latter, since it is usually held in this position, apparently as rigid as if it were a wire; and only now and then does it move, by a sudden jerk, and disappears in the oblique furrow—probably acting there in concert with the other cilia in the introduction of food into the mouth. The fourth and last kind of cilia of

* See 'Mind in Nature,' *et sup.* p. 148, fig. 80.

† See note *.

which I have to speak consists of two excessively faint, very long, and quite large, bristle-like filaments (sl , sl^1), which project from each end of the body. The straight one (sl) always precedes when the creature is in motion; and the curved one (sl^1) is attached a little to the left of the posterior end of the body. Both are always rigid when the animal is not in motion, but yet there can be no doubt that they are flexible; for at times they disappear suddenly, and probably are bent under the body. What their office is I cannot say, but conjecture, from their resemblance to what are called the saltatory bristles of other infusorians, that they are used as accessory means of sudden propulsion or leaping—a habit which seems to be the most frequent mode of leaving any point at which the creature has fairly come to a standstill.

“The contractile vesicle (cv) lies close to the forward end of the body, and corresponds in activity to the vivacity of the motions of the latter. It contracts every ten seconds, and with more vigour than any other that I know of. It is very conspicuous, as it is two-thirds of the time in an expanded state; and it disappears and reappears like the sudden closing and opening of a large eye.

“I have already indicated the position of the mouth (m) as being near the broader, anterior end of the oblique furrow, but again speak of it here in order to make the description of the digestive system complete. From the mouth (m) the food passes directly into the general cavity without going through any throat, and most frequently combines in large masses (d).

“The presence of a reproductive organ (n), which we find here in the form of a clear, colourless, globular body, when added to all the other systems which I have mentioned, puts this animal in the condition of a fully organized ciliated infusorian, and would seem to give us full warrant for believing it to be the culmination of a progressive development whose tendency is to pass through such forms of animate organization as we have just been tracing in the successively more and more complicated creatures whose images are before us.”

EXPLANATION OF PLATES V., VI., & VII.

The corresponding parts in the figures are lettered alike, excepting when otherwise stated in the description of any particular illustration.

a , anus: b , membranous collar; b^1 , edge of b ; b^2 , base of b : bk , the beaks of the valve of *Dysteria*: c , calyx; c^1 , aperture of c ; c^2 , lower half of c : cl , cl^1 , vibratile cilia: cv , contractile vesicle: d , digestive vacuole, or ingested food: e , furrow in fissigemmation; e^1 , anterior end of e ; e^2 , prolongation of e , e^3 : f , broad sulcus (in *Heteromastix*): f , flagellum;

*f*¹ minor flagellum; *f*², *gubernaculum*: *fr*, frontal area: *i*, neck or anterior half of body: *lp*, lip: *m*, mouth; *m*¹, jaws: *md*, monads of the Sponge, &c.: *n*, reproductive organ: *o*, ostioles: *pd*, pedicel; *pd*¹, top of *pd*; *pd*², forks of *pd*: *r*, retractor muscle; *r*¹, furrow in which *r* is imbedded and attached: *s*, eye-spot: *sl*, *sl*¹, saltatory cilia: *sp*, triradiate spicula; *sp*¹, aciculate spicula: *t*, margin of the inrolled side of *Anisonema*; *t*¹, the deep furrow or covered way behind *t*: *v*, broader valve of *Dysteria*; *v*¹, the narrower valve.

Figs. 1-4. *Monas termo*, Ehr.?. Fig. 1, a group of free monads, 500 diam.

Fig. 2, a free monad seen from the narrower side, with the lip (*lp*) next the observer, and the contractile vesicle (*cv*) in profile, 950 diam. Fig. 3, an attached form seen from the broad side, 1200 diam. Fig. 4, a free monad in the act of swallowing a large morsel of food, 950 diam.

Figs. 5, 5^a, 5^b, 6. *Monas neglecta*, n. sp. Fig. 5, broad-side view of a pedicellated monad, 950 diam. Fig. 5^a, a posterior view, showing the axial attachment of the pedicel (*pd*¹) and the contractile vesicle (*cv*) in profile, and the flagellum (*f*) in the distance, 950 diam. Fig. 5^b, a free monad in the act of swimming, 950 diam. Fig. 6, an attached form, contorted in the act of swallowing a large morsel of food, 950 diam.

Figs. 7-27. *Codosiga pulcherrima*, n. sp. Fig. 7, a colony of eight monads, drawn within an hour after the fissigemmation of three of its members, 150 diam. Fig. 8, a group of five, in a bird's-eye view, 500 diam. Fig. 9, a single monad with three contractile vesicles (*cv*), the dotted lines indicate the degree of the lateral vibrative expansion of the membranous collar (*b*), 950 diam. Fig. 10, the same as fig. 9, preparing to undergo fissigemmation; the body is contracted and widened, and the collar (*b*) broadened. Figs. 11-22, to illustrate the process of *fissigemmation*, 750 diam.; for particulars see the text (pp. 196-199). Fig. 23, a free monad in the act of swimming, the vibrating flagellum (*f*) acting as a propulsory agent and following in the rear, 950 diam. Fig. 24, a single pedicellated monad from old, stale water, the membranous collar (*b*) contracted into a cone, and the flagellum (*f*) vibrating rapidly, 950 diam. Fig. 24^a, a very large pedicellated form, just before *fissigemmation* begins, the body partially contracted, and the collar (*b*) vibrating; the peculiar sigmoid curve of the flagellum (*f*) is well shown here, 950 diam., —figs. 25, 26, 27, showing the different degrees of contraction of the membranous collar (*b*) of the same individual: in fig. 25 the flagellum (*f*) is vibrating rapidly, just at the moment when the collar (*b*) has returned to its usual form and attitude, 750 diam.

Figs. 28-32. *Salpingoeca marina*, n. sp. Figs. 28, 29, 30, the same individual in different states of expansion, 1900 diam. Fig. 31, the body completely filling the calyx, so that the latter is scarcely distinguishable except at its mouth (*c*¹), 1900 diam. Fig. 32, showing the calyx as a distinct envelope considerably separated from the body at the bottom (*c*) and at the aperture (*c*¹), 1900 diam. Fig. 32^a, an empty calyx closed, 1900 diam.

Figs. 33, 33^a, 33^b, 33^c. *Bicosoeca lacustris*, n. sp. Fig. 33, an adult with the lip (*lp*) nearest the eye, the flagellum (*f*) in the background, and the longitudinal furrow seen through the body. The flagellum (*f*) is uncoiling just as the body emerges from the bottom of the calyx (*c*), 950 diam. Fig. 33^a, a young

- animal in profile, showing the peculiar attitude and curve of the flagellum (*f*), the narrow aperture (*c*¹) of the calyx (*c*), and the unilateral attachment of the retractor muscle (*r*); the pedicel (*pd*) is just beginning to develope, 950 diam. Fig. 33^b, a young form partially emerged from the bottom of the calyx (*c*), the latter contracted at the mouth (*c*¹) and the flagellum (*f*) forcing its way through, as is usual, in a loop, 950 diam. Fig. 33^c, the same as fig. 33^a, retracted to the bottom of the calyx (*c*) and the aperture (*c*¹) of the latter nearly closed, 950 diam.
- Figs. 34, 35.** *Bicosarca gracilipes*, n. sp. Fig. 34, the longitudinal furrow (*r*¹) and the flagellum (*f*) next the eye, the lip (*lp*) in the background, 1900 diam. Fig. 35, the body retracted to the bottom of the calyx (*c*) and the flagellum beginning to uncoil, 950 diam.
- Fig. 36.** *Codonæca costata*, n. sp. The body seated in the bottom of the pedicellated calyx (*c*), 950 diam.
- Figs. 37, 37^a, 37^b, 37^c, 37^d.** *Salpingarca amphoridium*, n. sp.: all magnified 950 diameters. Fig. 37, an individual suspended freely in its calyx (*c*, *c*¹). The dotted lines indicate the attitude which the collar (*b*) assumed for a while during the observation upon this specimen. A particle of fecal matter has just left the anus (*a*). Fig. 37^a, the lower part of the calyx filled by the body, the upper part (*c*¹) free from the neck (*i*) of the animal, and the membranous collar unusually narrowed. Fig. 37^b, the calyx mostly filled by the body, the head (*i*) bent to one side, and the flagellum (*f*) in the act of expelling a particle of undesirable matter. Fig. 37^c, an empty calyx, slightly contracted in dimensions. Fig. 37^d, the body contracted and filling the calyx, and the membranous collar (*b*) partially retracted.
- Figs. 38, 39.** *Salpingarca gravis*, n. sp., 950 diam. Fig. 38, the body retracted within the calyx (*c*, *c*¹). Fig. 39, the same as fig. 38, partially protruded from the calyx.
- Figs. 40-44.** *Leucosolenia* (*Grantia*) *botryoides*, Bowrbk. Fig. 40, a colony of sponge, natural size. Fig. 41, view of a profile section of the monadigerous layer, the monads (*md*) closely packed together, side by side, with the membranous collar (*b*) and the flagellum (*f*) projecting into the general cavity of the colony, 95 diam. Figs. 42, 43, 44, isolated monads with the membranous collar (*b*) in various attitudes, 950 diam. See also fig. 64.
- Figs. 45, 46.** *Astasia trichophora*, Clap. Fig. 45, a dorsal view, the mouth seen through the head, and the *gubernaculum* (*f*¹) in the background, 500 diam. Fig. 46, the body in an amoeboid, contorted state, 500 diam.
- Figs. 47-63.** *Anthophyesa Mülleri*, Bory. Fig. 47, a colony of adults attached to a single tubular branchlet or pedicel (*pd*); one of the monads is in the act of passing a morsel into its mouth (*m*), 950 diam. Fig. 48, a pair of adults seen in profile, 950 diam. Fig. 49, a pair of young monads, one in profile and the other presenting its narrow side, 950 diam. Figs. 50 & 51, different attitudes of the same monad as the one in profile in fig. 49, during the introception of food, 950 diam. Figs. 52-61, to illustrate the process of fissigemmation, 950 diam. Fig. 62, a piece of a tubular branchlet like fig. 47 (*pd*), 1900 diam. Fig. 63, a piece of a flat branch from an old part of the colony, 950 diam.
- Fig. 64.** *Leucosolenia botryoides*, Bowerbk. A portion of the monadigerous layer (*md*) seen through the spiculiferous stratum, with the spicula next the eye, 500 diam.

Figs. 65-69. *Anisonema concavum*, n. sp.: all magnified 500 diameters. Fig. 65, a dorsal view, the inrolled margin (*t*) seen through the body. Fig. 66, a ventral view of fig. 65, the base of the gubernaculum (*g*²) covered by the inrolled edge (*t*). Fig. 67, a profile view of the right side of the body, showing its concavo-convex character. Fig. 68, an end view to show the lateral extent of the covered way from which the gubernaculum (*g*²) and the anterior flagellum (*f*) spring. Fig. 69, a ventral view of an animal which possesses two extra flagella (*f*²). It is probably in the incipient stage of fissigemination.

Figs. 70-74. *Heteromastix proteiformis*, Jas.-Clk. All the figures are magnified 500 diameters. Fig. 70, profile view of the right side of a fully extended animal, the gubernaculum (*g*²) trailing beneath. Fig. 71, the same as fig. 70, in a partially contracted state. Fig. 72, an individual seen directly from below, with its anterior end strongly retracted and broadened. Fig. 73, an animal partially contracted and propped up on its tail by its flagella (*f*, *f*²), and exposing its ventral ciliated furrow (*f*) to full view. Fig. 74, an end view of the head, with the group of cilia (*cl*) on the lower side.

Figs. 75, 76. *Neuronema instabile*, Jas.-Clk. Fig. 75, a dorsal (ventral, homologically speaking) view, 1000 diam. Fig. 76, an end view of the head; the contractile vesicle (*cv*) in the foreground, and the flagellum (*f*) in the distance; a part of the ventral side is destitute of cilia: 500 diam.

Figs. 77, 78. *Dysteria prorafrons*, Jas.-Clk. Fig. 77, a view of the dorsal (homologically the ventral) side, the broader valve (*v*) next the eye, and the narrower three-beaked valve (*v*¹, *bk*) in the extreme distance, 600 diam. Fig. 78, a foreshortened view of the body as it appears when turned up on its right edge; the head next the observer, and the pivot (*g*²) in the distance: 600 diam.

XXXIV.—Description of two new Gobioid Fishes from Sarawak. By Dr. A. GÜNTHER, F.R.S., F.Z.S.

[Plate XII.]

THE Marquis J. Doria has sent to the British Museum a collection of Fishes made by him in Sarawak (Borneo). Several of the species are new to the fauna of Borneo*, viz. *Nemachilus fasciatus* (K. & v. H.), *Apocryptes viridis* (H. B.)†, *Exocoetus oligolepis* (Blkr.), *Caranx atropus* (Schn.), *Dussumieria acuta* (C. & V.), *Pristigaster macrognathus* (Blkr.), *Saurida argyrophanes* (Richards.). *Eleotris melanostigma* (Blkr.) is not specifically distinct from *E. butis* (H. B.), a species ranging from the east coast of Africa to Borneo and China. The total number of species known from Borneo

* See Bleeker, "Dertiende Bydrage tot de Kennis der Visch-fauna van Borneo," in Act. Soc. Sc. Indo-Neerl. 1860.

† This is not a *Boleophthalmus*, to which genus it has been referred by all previous authors.

amounts now to about 340, which is evidently only a fraction of the number actually existing in this island.

Two of the species were desiderata for the British Museum Collection, viz. *Synanceia asteroblepa* (Richards.) and *Apo-cryptes borneensis* (Blkr.); and the following appear to be new to science:—

Gobius Doriai. Pl. XII. fig. A.

D. 6 | $\frac{1}{2}$. A. 8. L. lat. 27.

Head broad, depressed, rather broader than deep; it is naked, as is the nape and the lower part of the thorax; there are only a few scales on the hind part of the gill-cover. Sides of the head with several series of pores. The length of the head is contained thrice in the total length (without caudal), the height of the body thrice and two-thirds. Snout broad, depressed, shorter than the eye, which is two-sevenths of the length of the head. Cleft of the mouth wide, extending beyond the front margin of the eye. Canine teeth none. Interorbital space flat, broad. There are ten longitudinal series of scales between the origins of the second dorsal and anal. Scales not serrated. Fins low and short. Brownish black, encircled by three broad yellowish bands—the first round the nape and opercle, the second corresponding to the space between the two dorsal fins, the third on the caudal peduncle. Caudal fin yellowish, with the base deep black.

I have named this very fine species after its discoverer. Three examples, 15 lines long, are in the collection.

Eleotris dasyrhynchus. Pl. XII. fig. B.

D. 6 | 9. A. 8. L. lat. 29.

Head very broad and depressed, cheeks swollen, the greatest width of the head being equal to its length, without snout. The gill-covers and the upper part of the cheek are scaly, the remainder of the head naked. The præorbital and the supraorbital ridge are beset with rough prominences or spines. The length of the head is contained thrice and one-third in the total length (without caudal), the height of the body four times and three-quarters. Snout very broad and depressed. Eyes exceedingly small, directed upwards, separated by a broad flat space. Teeth small, in a band, those of the outer series being a little larger; palate toothless. Mouth wide, the maxillary reaching behind the orbit. Præoperculum without spine. Scales ctenoid; there are eight longitudinal series between the origins of the second dorsal and anal fins. The posterior part of the second dorsal and anal are slightly elevated; caudal rounded,

of moderate length. Brownish black, each scale with the margin lighter; back with two or three yellowish blotches: the first, at the origin of the spinous dorsal, is sometimes absent; the second at the origin of the soft dorsal, and the third on the back of the caudal peduncle. Dorsal fins coloured as the body underneath; caudal nearly uniform white. Pectoral rays variegated with black.

Three examples, the largest $2\frac{1}{2}$ inches long, are in the collection.

XXXV.—*Notes on the Remains of some Reptiles and Fishes from the Shales of the Northumberland Coal-field.* By ALBANY HANCOCK, F.L.S., and THOMAS ATTHEY*.

THE coal-shales of the Low-Main seam at Newsham and Cramlington, near Newcastle-upon-Tyne, so prolific in fish-remains, have also yielded some very interesting reptilian fossils, the largest and most important of which are the posterior and upper portions of two crania that are undoubtedly Labyrinthodont. These are apparently closely related to *Loxomma Allmanni* described by Prof. Huxley in the Proc. Geol. Soc. vol. xviii. p. 291 (1862), though apparently generically distinct from that form. Two sets of sternal plates have also been found in the same locality, as well as several ribs, a few vertebrae, two of which have the neural arch complete and most of the processes attached. Several premaxillaries and three or four portions of mandibular bones, with the teeth attached, have also occurred. All these most probably belong to the same large Labyrinthodont Amphibian.

Besides the above interesting remains, an almost entire individual of a new species of *Ophiderpeton*, Huxley, has occurred, as well as several other fragmentary reptilian fossils. And what we now propose is to give in the following pages more or less detailed descriptions of all these, and likewise of some fish-remains that have been found in the same locality.

Pteroplax cornuta, nobis.

The two cranial fragments of the reptile designated as above are each composed of the two quadrate supra-occipitals, the two parietals, portions of the elongated frontals, the post-frontals, and the epiotic bones, all of which are firmly united into one great pyriform shield by well-knit serrated sutures, which can be traced with sufficient accuracy. This shield

* Read at a Meeting of the Nat. Hist. Soc. of Newcastle-upon-Tyne and Tyneside Nat. Field Club, March 12, 1868.

corresponds very well in form to the central portion of the fragmentary skull figured in the paper already referred to, by Prof. Huxley; but in the new form it is less angulated. The frontals, too, appear to be longer, though their anterior extremities are broken away; the post-frontals are arcuated in the same manner, but not to the same degree, forming the inner posterior boundary of the large orbits, and their connexions with the parietals and frontals are similar. The parietals widen backwards; and the foramen, which is situated in the line of the median suture, where there is an elongated eminence, is a little behind their centre, and is slightly lengthened in the antero-posterior direction. In the larger specimen it is one-fourth of an inch in length, in the other it is a little shorter. The occipital margin is concave, the epiotic bones projecting boldly backwards, and each terminating in a slightly arched, pointed, diverging horn or spine, about an inch long. In neither specimen are these horns (which are very similar to the "postero-internal cornua" of *Keraterpeton**) perfect; but in the smaller individual the upper surface only is wanting.

The external surface of the cranial shield is strongly sculptured in the usual manner observed in Labyrinthodonts; that is, it is covered with anastomosing ridges separating pits and grooves; but this peculiar ornament is not equally distributed: it radiates from the centre of the shield, where it is almost obliterated, and is strongest at the margins. Here the pits and grooves are deep and strongly defined. A rather wide rounded groove extends along the outer margin of the frontals, resembling the mucus-grooves of the Labyrinthodonts.

The larger of these shields is seven inches long, including the posterior horns, and three and three-quarters inches wide. The other is six and one-quarter inches in length, and nearly three inches wide at the broadest part. Prof. Huxley estimates the width of the skull of *Loxomma Allmanni*, including the lateral portions, which are entirely wanting in our specimens of *Pteroplax cornuta*, at ten and three-quarters inches; and as it appears that the central portion, or that which corresponds to the cranial shields above described, is about one-third the entire width, we are enabled to form an approximate estimate of the width of the skull of the new form, on the assumption that it had similar lateral cranial expansions. On this basis our new Labyrinthodont must have had a skull eleven and a quarter inches wide at the posterior or widest part; and, following up Prof. Huxley's estimate, it could not be less than fifteen inches in length. If the body, therefore,

* Trans. Royal Irish Academy, vol. xxiv., Science, p. 351, pl. 19.

was only seven times the length of the cranium, which is about the proportion of these parts in *Keraterpeton Galvani*, a comparatively short species, then *Pteroplax* must have been eight or nine feet long.

This new genus, though it seems, as above stated, to be nearly related to *Loxomma*, resembles not a little, in the general form of the skull, as far as it can be determined, *Dasyceps Bucklandi**. The concavity of the occipital margin and the two lateral cornua are very similar in both species; but in the latter these processes or horns are more robust, and do not look so spine-like as in *Pteroplax cornuta*. The proportions and forms of the component bones, too, are very different; and the parietal foramen in *Dasyceps* is much nearer the occipital margin, as are also the orbits, which are likewise very much smaller. The resemblance, also, of these cranial bones to those of *Keraterpeton* cannot be overlooked, so far as they can be compared. The general form of the crown of the head, with the narrow projecting frontals and concave occipital margin, together with the "postero-internal cornua," are all remarkably alike in the two forms; but, from the deficiency of surface-sculpture in that animal, and its comparative smallness, it would seem that they cannot be considered congeneric.

Four left premaxillaries have been obtained; and all of them have a portion of the nasal bone attached, as well as several teeth more or less perfect. The premaxillary is about two and a half inches long, and upwards of half an inch wide; it is arched most strongly towards the anterior symphysis, which is oblique and coextensive with the width of the bone; behind, it is prolonged, the articular portion being wedge-shaped; the surface is strongly sculptured into elevated anastomosing ridges and depressions; and they all exhibit two strong, wide, round grooves on the external surface, one of which passes from the front, the other from behind, converging and meeting at nearly a right angle, close to the alveolar margin. These grooves are similar to what have been denominated mucus-grooves in the Labyrinthodonts, and are exceedingly like those figured and described by Prof. Owen on the muzzle of *Labyrinthodon leptognathus*†. And in this instance they seem to indicate the boundary of the nasal bone, which is apparently of a lozenge-form, probably somewhat prolonged backwards. Half the circumference of an external nasal orifice is distinctly perceptible in two of the specimens; it is circular, and about one-quarter of an inch in diameter: the two

* Memoirs Geol. Survey, 1859, p. 52.

† Trans. Geol. Soc. ser. 2. vol. vi. p. 417, pl. 43. fig. 1.

must be placed considerably apart from each other, and not much in advance of the posterior margin of the nasal bone; at least it is only a short way in front of the posterior mucus-groove.

There are five or six conical teeth in each premaxillary; they are stout, grooved, and circular at the base, with the crown compressed in the direction of the length of the jaw; they are provided with wide cutting-edges, and are rather abruptly pointed. The largest are upwards of half an inch in length, allowing for their lost apices. The three anterior are much larger than the rest, and they are placed at some little distance apart, there being large depressions between them in the alveolar groove, apparently for the reception of the crowns of the mandibular teeth. The two or three posterior teeth are comparatively small, and are placed nearer together than the anterior.

Two specimens of the anterior portion of the left mandible have also occurred, the largest and best preserved of which is four inches long and about two and a quarter inches wide. The surface exhibits the same ornamentation as the other bones. The symphyseal surface is perfect; it is considerably longer than the width of the ramus, being extended by a process from the inner or lower margin of the bone; there is a trace of a mucus-groove along the inferior border of the ramus. None of the teeth in these specimens are perfect; but enough is left to show that they are similar to those already described. The first tooth is small, and is placed close to the symphysis; the second is very large, and is immediately behind the first; it is half an inch in diameter at the base; a large depression, five-eighths of an inch wide, succeeds this, and then four small teeth placed close together, the two posterior of which are larger than the anterior pair; but one of them is indicated only by a mere fragment of dentine; then comes another large depression, half an inch wide, but whether or not this is for the reception of the crown of a maxillary tooth, or is the impression of the base of a tooth belonging to the mandible, it is difficult to say. Close to this depression is the base of another tooth equal in size to the large anterior one. At this point the alveolar groove is broken away; and shortly after, the fragment of the ramus terminates. The alveolar groove is distinctly defined, but widens inwardly to accommodate the bases of the large teeth, which consequently have the appearance of being placed within the smaller ones; they form, however, with the latter only a single row, and the outer borders of all are placed on the same external line. The other ramus is very imperfect; but, as far as they are traceable, the teeth have the same arrangement.

Besides the above, we have also obtained from the same locality portions of three other mandibles: one belongs to the left ramus, and is in a bad condition; two are in a good state of preservation, but, unfortunately, they both represent the same portion of the right ramus, the anterior part of each being wanting, as also the proximal extremity. They each measure about six inches in length, and widen a little backwards, where they are two and a half inches broad. If we add to the length of these fragments that of the anterior portion before described, and allow for the parts that are wanting, it would appear that the ramus could not be less than twelve or thirteen inches long. The internal cartilage having been removed, the lateral bony walls have collapsed and are inclined inwards. The jaw is consequently comparatively thin and flattened. The external surface exhibits the peculiar ornamentation in a very beautiful manner. It is the same as on the other bones, the sculpturing extending over the whole surface in the form of smooth elevated ridges composing an irregular reticulation, with the meshes or depressed spaces deep and of various forms, frequently angular, sometimes rounded, but most commonly elongated; so that the reticulated ridges, on the whole, have a somewhat dendritic appearance. This striking embossed ornament closely resembles that of *Labyrinthodon leptognathus* and *L. pachygnathus*; only it is considerably finer*. The inner surface of the bone is smooth, as well as the external border of the alveolar ridge; and there is a groove along the lower margin extending the whole length of the fragment.

The teeth exhibit very distinctly on the upper portion or crown the wide, compressed, sharp cutting-edges, and on the base the strong fluting or grooves. In several the points are quite perfect, and are decidedly lancet-shaped. The teeth are ankylosed to the bottoms of shallow pits in the not by any means deep alveolar groove.

In one of the fragments there are seven teeth; in the other, four perfect and three imperfect. In the latter the anterior tooth is a little more than half an inch long, and the others gradually diminish in size backwards, and are placed considerably apart from each other, the spaces between them being nearly three-eighths of an inch wide. In the other fragment the four most perfect teeth appear to be situated at the posterior extremity of the alveolar groove, though the jaw is continued for a considerable distance behind them. The anterior of these four is not quite half an inch long, and the others diminish gradually in size posteriorly, the last being not much

* See Prof. Owen's paper, Trans. Geol. Soc. ser. 2. vol. vi. pls. 43, 44.

more than half that length; but its extremity is not quite perfect. The three imperfect anterior teeth are very much larger than the four posterior ones; the largest of them, which is the centre one, cannot have been less than an inch in length and three-eighths of an inch wide at the base. They are all placed considerably apart from each other; but they are not quite so widely separated as those in the other fragment.

We have two other fragments of jawbones of this reptile; but they are in such an unsatisfactory condition that not much can be said about them. One of them, however, is probably a maxillary bone; it is six and a half inches long, and an inch and a half wide; but it is so imperfect that its form is not determinable, and it is much encumbered with other bones. A portion of the alveolar border is nevertheless distinctly displayed, with five close-set teeth, the largest of which is upwards of half an inch long. Other fragments of teeth are scattered about. We have also a confused mass of apparently cranial bones, which show the peculiar surface-sculpture. A portion of a jaw with a tooth or two is mixed up with these fragments.

For some time these portions of mandibles were all supposed to belong to *Rhizodus lanceiformis*, Newberry, as the teeth attached to them are undoubtedly similar to those of that reputed fish. But on considering that the sculpture of the bone-surface is exactly like that of the cranial and premaxillary bones, that the teeth of the latter are similar to those of the mandibles, and that the teeth of both exhibit precisely the same Labyrinthodont structure when examined in transverse section, the conclusion that these mandibular fragments really belong to this new Labyrinthodont is quite irresistible. The piscine nature of *R. lanceiformis* is therefore questionable. Certainly the teeth usually so designated belong to this reptile; and unless other evidence be forthcoming, this reputed species of *Rhizodus* will have to be erased from the list of Carboniferous fishes.

The two sets of sternal plates are characterized by the same surface-ornament which we have found on the other bones; and though neither of them is perfect, sufficient is preserved to enable us, by the aid of both, to form a very good idea of their shape and characters. In the finer and larger specimen, all the three plates are present, and by their position exhibit, though considerably displaced, their relation to each other. The posterior ends of the two lateral plates lie in juxtaposition, overlapping the anterior portion of the central plate, and diverging backwards; a portion only of the posterior margin of the central plate is exposed. By removing the matrix,

however, from the underside in both specimens, the entire form of this plate is developed. The arrangement and general appearance of the three plates are very similar to those of *Loxomma Allmanni* figured by Prof. Huxley in the paper already referred to; only the central plate is not so much produced posteriorly and the lateral ones are much more elongated, agreeing apparently in this latter respect with *Archegosaurus*, in which Prof. Owen remarks that the lateral plates "are shaped like beetles' elytra"*. Those of *Pteroplaux* certainly resemble in form elongated elytra; but, unfortunately, these plates are not perfect: even in the best-preserved specimen only the posterior extremities are entire; they are rounded diagonally, the slope being apparently upwards and outwards. What remains of the most perfect plate measures upwards of seven inches in length, and three and a quarter wide. That which seems to be the external margin is thicker than the inner or opposite margin; and here the surface-sculpture, which is like that of the other bones, is strongest.

The central plate, which in Labyrinthodonts is usually rhomboidal, is peculiar in form: the two lateral angles are much produced, forming broad rounded lobes or wings (hence the generic appellation); their anterior margins have a sigmoidal curve extending to the anterior angle: the posterior margin is almost straight, but is a little produced in the centre, where there is a broad flat process extending backwards; this, however, is not perfect in either specimen. Here the plate is thickest, and on the surface there is a strong sinuous ridge which extends transversely from side to side, just a little in advance of the posterior margin. When the lateral plates are in their proper position, their posterior extremities would, no doubt, rest against this ridge, the anterior extremities converging forwards. The central plate is upwards of four inches long and six and three-quarters wide. The surface is not sculptured in the usual manner, and must be almost entirely overlapped by the lateral plates.

The other set of sternal plates is very imperfect; the characters, however, of the central plate are well developed; and it fortunately happens that while the right lobe of this plate, in the former specimen, is imperfect, the right lobe of this is quite entire, the other one being injured; so that, by the aid of the two specimens, the form can be perfectly restored.

The two vertebræ with the neural arches complete are in a very good state of preservation; the centrum is quite perfect in one, and almost perfect in the other; and between the two

* Palæontology, p. 179.

all the processes can be determined more or less completely. They were found at Newsham, but at different times. These very interesting relics closely resemble the figure of the vertebra of *Anthracosaurus* given by Prof. Huxley in the 'Journal of the Geological Society' (1863, vol. xix. p. 63). Our specimens, however, are larger, the neural arch differs a little in form, and there is a very minute notochordal foramen.

The body or centrum is biconcave, and appears to be considerably flattened lengthwise. The margins of the articular surfaces are reflected, so that in section the faces of the body would present a sigmoid curve from the centre to the margin. The height is a little more than the breadth, and the circumference at the sides and below is well rounded, though there is here and there a tendency to angularity; but whether this arises from original conformation or from accidental and unequal reflection of the margin, cannot be determined. The upper margin of the anterior face is produced a little in the centre, forming a rounded elevation immediately below the neural arch, and is angulated at the flanks. The same region in the posterior face presents a shallow concavity, exactly similar to that represented in Prof. Huxley's figure referred to. The sides of the body are somewhat concave, and transversely wrinkled or coarsely striated. The minute notochordal foramen, which is only large enough to admit a stout knitting-needle, is difficult to determine, though there can be no doubt of its existence.

The neural arch is comparatively small; it is oval, the long axis being perpendicular; the lips of the arch are produced a little in front; behind they do not appear to be so. The walls of the arch are very stout, and pass upwards to form a long high spinous process, which is nearly as high as the centrum, and is thin, being much compressed laterally.

The anterior zygapophyses are large; their articular surfaces are hollow and elongated transversely; their inner borders are confluent. The posterior pair are much distorted; but they appear to form wide, transverse articular surfaces, the faces of which look downwards.

The transverse processes are perfect in neither vertebra, though in one of them the extremities only are lost; they are broad and much compressed from front to back, and originate apparently in the sides of the neural arch and the upper surface of the centrum. They project almost horizontally; but so much of their extremities is wanting that there is no distinct evidence that they are divisible into an upper and a lower portion, corresponding to the head and tubercle of the rib. The upper portion, however, is thicker than the lower.

The measurements of the larger vertebræ are as follows:—

	inch.
Height of the body of the vertebra	1·9
Transverse diameter	1·8
Length	0·8
Height of neural arch	0·4
Height of spinous process	1·7
Length of ditto	1·0
Thickness of ditto	0·2
Width of transverse process	0·7
Thickness of ditto	0·3

Several other well-ossified vertebral centra have occurred at Newsham; they have all, however, lost the neural arch and most of the processes. Some, having a minute notochord, probably belong to *Pteroplax*; and two in particular, one of which is an inch and a half high, and about the same wide, agree perfectly well in form with the two above described. These have on the upper surface two peculiar, wide, arched, transverse, sessile processes or lobes, with the anterior faces a little hollowed. There can be no doubt that these belong to this Labyrinthodont, and are probably caudal vertebræ.

There are three or four other vertebræ, quite as large as the above, with a notochord nearly half an inch wide, and the remains of lateral processes. These may probably belong to fishes; but we know of no fish in our coal-shales to which they can be assigned.

The four or five ribs that have turned up at Newsham are not well preserved: two are lying in contact with one of the cranial shields, one above, the other below it; but in both instances the extremities are either lost or much injured. The largest is five and a half inches from end to end, and four-eighths of an inch broad; it is well and regularly arched, and appears to be a little flattened; a wide groove extends along the surface; and one of the extremities, which is crushed flat, exhibits distinct traces of a tuberculum and capitulum, the latter projecting quite four-eighths of an inch beyond the former, and continues the concavity of the inner margin of the rib. The tuberculum is reflected a little, so as to interrupt the convexity of the opposite margin. In short, this rib, as far as can be determined, agrees very closely with that of *Anthracosaurus* as figured and described by Prof. Huxley (*loc. cit.* p. 63). In another specimen the proximal extremity is better preserved; and in it the head and tubercle are quite in accordance with the above description.

Another rib, which probably belongs to this or to some other

equally large Labyrinthodont, differs considerably from those just described. It is not quite four inches long, and near to the proximal end it is upwards of half an inch wide; the sides are flattened from before backwards, and exhibit a wide shallow groove from one end to the other. The tuberculum is scarcely distinguishable from the capitulum, except by its projecting boldly outward from the convex margin of the rib; its articular surface is continuous with that of the capitulum, forming with it a wide diagonal termination. Thence the rib tapers rather rapidly to the distal extremity, which is a little recurved.

Two or three limb-bones have likewise been found,* which, from their size, probably belonged to this species. One of these, apparently a femur, is an inch and a half in length and five-eighths of an inch wide at the middle of the shaft, which is much compressed from front to back, and is a little arched in the same direction; there is a longitudinal depression extending from end to end. The extremities are much expanded, and they both appear to have double articular surfaces; that which is assumed to be the distal extremity is more expanded on one side than on the other.

From the shortness of this bone it would seem that the limbs of this animal were but feebly developed in comparison with the size of the body.

In concluding this description of the remains of this fine large Labyrinthodont reptile, a few words may be desirable on its relationship with the generic forms previously known. It has been already stated that it is closely allied to *Loxomma*, with which it agrees in having large and probably oblique eyes, placed near together and in a backward position. It agrees pretty well, too, with it in the general form of that assemblage of bones which we have called the cranial shield, though the curves are more flowing. But the parietals differ considerably in shape: in *Loxomma* they appear to be simply elongated, and scarcely, if at all, enlarged behind*; while in *Pteroplax* they are much enlarged posteriorly, and the frontals seem to be more produced. The sternal plates likewise differ from those of Prof. Huxley's genus, in which the lateral ones are quite short; but in *Pteroplax* they are much elongated, agreeing in this respect with *Archegocaurus*; and the central plate in *Loxomma* is devoid of the remarkable lateral lobes which characterize that of our genus.

We have also seen that this new reptile resembles to some extent *Dasyceps*, particularly in the two occipital horns; but the small eyes, backward position of the parietal foramen and

* Proc. Geol. Soc. vol. xviii. p. 292, pl. 11.

external nostrils, and the difference in the form of the cranial bones, as well as the smallness and different character of the teeth of that genus, sufficiently distinguish it from *Pteroplax*.

This new genus is also related to *Anthracosaurus*, as is apparent by the similarity of the vertebræ, the only difference of importance being that in this new Labyrinthodont there is a minute notochord, while the centrum of *Anthracosaurus* is completely ossified, and the neural arch of the former is oval instead of being triangular as it is in the latter. The occipital region, also, in the two forms is very different. And, the teeth disagree both in form and minute structure; indeed, the strongly compressed crown, with its wide cutting-edges, seems very characteristic in *Pteroplax cornuta*.

When the tooth is seen in transverse section, converging spaces are observed dividing the internal vertical folds or plicæ of dentine; these spaces are widest towards the periphery of the tooth, and are nearly all lost before they reach the pulp-cavity, the plicæ having coalesced at their internal extremities*. The plicæ are much undulated or lobulated, and have, extending through the centre in a radial direction, a double line of granular matter, divided by a thin, clear, homogeneous substance. This compound line takes an undulatory or zigzag course, and sends a simple process from each angle into the lateral lobes or undulations. The two granular lines are continuous with a similar line that follows the sinuosities of the peripheral dentine; and the clear layer between these granular lines appears to be continuous with the clear coating of the tooth, which would seem to be composed of cement, the enamel probably not extending to the base of the tooth. The Labyrinthodont structure of the tooth would therefore appear to be formed by the vertical infolding or plication of the peripheral wall of dentine and its external coating. It is evident, then, that the minute structure of the tooth of *Pteroplax* differs considerably from that of *Anthracosaurus*, in which, to Prof. Huxley, the radiating plicæ are not formed in way.

Ophiderpeton nanum, n. sp.

A single individual of a curious serpent-like Labyrinthodont, which apparently belongs to this genus, has been found at Newsham. It is not, however, in a good state of preservation, though the characters are sufficiently distinct to permit of the

* Since the above was in print we have examined other sections of the tooth, and find that the radial spaces dividing the plicæ of dentine are occasionally continuous with the pulp-cavity; it would therefore seem that in the minute structure the tooth differs less from that of *Anthracosaurus* than we supposed.

determination of its specific and generic relations. From the head to the caudal extremity, which appears imperfect, it is five and a half inches long, allowing for the sinuities; as it lies it is about an inch shorter. The head is so much crushed that none of its characters can be determined. In its disturbed state, however, it is three-tenths of an inch long, and nearly two-tenths broad. Thirty-three vertebræ can be counted in a pretty continuous series extending from the head; they may, however, be estimated at forty. They do not appear to vary much in size; the largest are one-tenth of an inch long, and they are decidedly hourglass-shaped. The processes cannot be determined, though it is evident enough that the spinous process is not much elevated and that it is shorter than the centrum.

Numerous rather long, delicate, slightly curved ribs are scattered along the sides, from the head almost to the caudal extremity. The proximal end is bifid, the capitulum being longer than the tuberculum. The ventral shield is distinctly displayed; it extends from about half an inch behind the head almost to the other extremity of the body, in the form of a broad band, and is composed of very numerous, delicate, slightly curved, much elongated scales, with the extremities pointed. They are arranged transversely; and the ends of the parallel rows overlap each other laterally.

The extreme delicacy of these scutes, which are almost filamentous, distinguishes this species from *O. Brownriggii*, described by Prof. Huxley*. Its diminutive size is also characteristic. No trace of sternal plates or of anterior and posterior limbs are observable.

Reptile, species undetermined.

A single specimen of the central sternal plate of a second large Labyrinthodont was obtained at Newsham some time ago. It is nearly five inches long and about three and a quarter wide, and is pretty regularly lozenge-shaped, with the posterior angle produced, forming a wide, depressed, tapering process half an inch broad at the termination, which is truncate. The sides thence to the lateral angles are a little concave, and from the lateral angles to the anterior extremity (which is not much produced) are slightly convex; the anterior slopes are much shorter than the posterior ones. The surface is very rugose; with the usual Labyrinthodont structure, which, however, is not so sharply defined as it is in *Pteroplax*. The depressions and ridges have a radial disposition; the

* Trans. Royal Irish Academy, vol. xxiv. p. 351, Science (1867).

plate is about one-eighth of an inch thick, but diminishes in substance towards the margins.

In this interesting fossil we have evidence of the presence of another large Labyrinthodont in the Northumberland coal-field, which, judging from the measurements of the plate, cannot be less than the large species previously described. And if we look to the form of the plate and the character of the surface-ornament, it would seem probable that it belonged to a reptile not only specifically but likewise generically distinct from *Pteroplar cornuta*.

Two or three other different kinds of small sternal plates have likewise been found; but particular allusion will be made only to one species, which appears to be the best characterized. The others must be left for further elucidation.

Of this species there is a set of three plates lying in juxtaposition, apparently not very much disturbed; two are very nearly perfect, the third is partially destroyed. They are rounded and somewhat elongated, particularly one, which is probably a lateral plate; it is upwards of half an inch long.

In form and size these plates resemble those of *Keraterpeton*, and in structure they are almost identical. These specimens, as well as those figured of that genus by Prof. Huxley in the memoir before quoted, appear to have lost the external surface, and the bone-fibres beneath are exposed to view, radiating and anastomosing in a very regular manner from the centre of ossification, which is a little elevated. The appearance is very peculiar, and not a little resembles that of some specimens of *Synocladia* from the Magnesian Limestone. In the species before us the bony reticulation is not quite so fine as it is in *K. Galvani*.

[To be continued.]

XXXVI.—Remarks on the Names applied to the British Hemiptera Heteroptera. By J. W. DOUGLAS and JOHN SCOTT.

UNDER the above heading (*antè*, p. 94) Mr. Pascoe has very fairly criticised the nomenclature adopted in certain cases by hemipterologists, with a special reference to us; and we now claim to say a few words in reply.

The criticism falls chiefly under two heads:—

1. "The application of the generic names of the older authors to obscure, sometimes extra-European species, instead of to the larger number of better-known species which those authors must have had most prominently before them, thus rendering the use of new names necessary." As an example, is taken "the

old name *Cimex*, under which Linnæus was content to include all the Hemiptera Heteroptera known to him." Now this is not strictly the fact; for both in the 'Fauna Suecica' and in the 'Systema Naturæ' there are, besides *Cimex*, the genera *Notonecta* and *Nepa*, both of which latter names have been retained by all authors. With respect to *Cimex* the case is different. In the 'Systema,' where Linné first characterized his genera, the following characters are given for *Cimex*:—"Rostrum inflexum. Antennæ thorace longiores. Alæ 4, cruciato-complicatæ: superioribus antice coriaceis. Dorsum planum thorace marginato. Pedes cursorii." Yet immediately afterwards he puts the exceptional section "**a** Aptera," containing only one species. It is clear therefore that Linné never could have intended the apterous *lectularius* to be the type of his winged genus. Indeed, looking at the very heterogeneous nature of the species composing the genus as left by him, and the breadth of the characters laid down, it seems equally clear that he had no idea of a generic type, or that the first or other species on his list should be taken as representative. Fabricius must have seen this; and when he had to break up the Linnæan genus, he very properly eliminated the exceptional *lectularius*. It is true he at first (in the 'Entom. System.') placed it under the title of *Acanthia* at the head of many unrelated species; but he afterwards (in the 'Syst. Rhyng.') restricted the genus to *lectularius* and another close ally. In the interval between the publication of these works, Latreille, having retained *Cimex* for *lectularius*, applied the Fabrician name *Acanthia* to other species; but Fabricius, coming after him, showed, in the 'Syst. Rhyng.,' that Latreille had not rightly interpreted his idea. Thus Mr. Pascoe's objection that "it is difficult to say why the Fabrician name *Acanthia* should have been preferred," is not tenable. The excision of Linné's first section under another name being valid, the question remained which of the other nine sections into which Linné had divided his genus was to be taken as representative; and, considering that each of them equally conformed to the characters laid down primarily, it is no wonder that no two subsequent authors, including those "most conversant with general entomology" (Fabricius, Burmeister, Germar, Kolenati, Zetterstedt &c.), agreed—showing also that there was no generally received rule by which their proceedings were to be regulated. If the principle apparently adopted for *Notonecta* and *Nepa*, of taking the first-mentioned species as the type, were esteemed binding, then it is curious that the first two of the section "**b**" are within Mr. Pascoe's inhibited line of "extra-European species,"

and that none of the species in the section have been taken by any author as exclusively representing the genus *Cimex* of Linné, although some of them are so common that they must have been among those that Linné "had most prominently before him."

But if, by common consent, it were agreed that the name *Cimex* was to be retained for certain species, could the genus so restricted and constituted (a mere fragment of the Linnean creation) be called, with any sense of truth, *Cimex* of Linné? A part is not equal to the whole: the play of Hamlet with the part of Hamlet left out "by particular desire" is not Shakespeare's work; neither is the genus *Cimex* of Latreille, Westwood, Blanchard, Gerstäcker, or Pascoe that of Linné; it only represents the *Cimex* of the particular author. If the name of Linné is still in any case to be appended to any portion of his mutilated genera, let it be clearly seen that the species included therein are really representative of his idea, or, if not, that the retention of the appellation is merely by courtesy, and in remembrance of the labours of the illustrious Swede, rather than a logical necessity. But the fact is that the genera of Linné represent the modern sections or families; and if the Linnean appellations were reserved and applied only to such divisions, the justice and propriety of the case would be met far more efficiently than by the use of the names of the original extensive genera for mere fragments of them—a proceeding which, in the very nature of things, must be more or less arbitrary, and subject to the caprice of any individual systematist. To this end it must come at last, whether the way be led by "authors conversant with general entomology" or by mere hemipterologists, which latter are said to be the only sinners against the Pascoean Canon No. 1.

As to this last allegation, let us see what has been done in two or three instances by coleopterists and lepidopterists where they had large genera to deal with. In Coleoptera the names *Curculio*, *Cerambyx*, *Chrysomela*, and *Leptura* have either been dropped or applied without any rule to common or uncommon, European or exotic species, and without regard to the position they held in the Linnean list. In Lepidoptera, to take a single instance, the name *Noctua* has either been omitted or employed to designate insects which, if common, are certainly inconspicuous, and have no claim to be taken as special representatives. Instances in other orders might be adduced to show that it is not only students of Hemiptera that have erred in "the application of the generic names of the older authors to obscure, sometimes extra-European species;" but these may suffice.

Passing to the remarks on the Fabrician genera, Mr. Dallas is well enough able to take his own part in explaining why, when revising the genus *Cydnus*, he retained the name for a single species; nor do we care to inquire why Fieber, Gerstäcker, and Bärensprung differ in their interpretation of the genus; for, as we see by the light of what has been done in other orders, there was no rule to guide them, and we believe that all are wrong in principle, as shown above.

As to *Tetyra*, Fab., it was Laporte, and not Fieber, who eliminated certain species of that genus under the name of *Eurygaster*; and it is therefore improper still to refer them to *Tetyra* by the authors quoted. From *Asopus*, Burm., Amyot and Serville selected *A. cærulea* (which can only be considered at most a type of part of Burmeister's genus) as the type of a new genus (*Zicrona*); and the European species of *Asopus*, except *luridus*, having been referred by different authors to other genera, *luridus* was the only one left for Fieber to take as the representative of the genus; but it would have been better if, as Mr. Pascoe says, he had employed Herrich-Schäffer's name *Podisus*, as he has indicated in the 'Schlüssel.'

2. "Giving new names to such genera as were formed by the union of two or more genera of a preceding writer."

The argument of this objection is met by anticipation in the foregoing remarks; for it cannot be said with any truth that the name of a thing should be retained for another thing which is differently constituted, but of which the former may be an ingredient. A chemist when he combines two or more elements does not give the name of any one of them to the resulting compound; neither can it be rightly done in the labours of the naturalist. We heartily wish it could.

Whether or not the names we have given to the combinations of the genera mentioned will stand is a very small matter, if the union of species proposed be received as good. Nor are we anxious on this latter point, as we do not attach an exaggerated importance to genera as now understood, regarding them rather as useful for classification than absolutely natural divisions*. *Microsynamma*, Fieb. (MS.), was discarded for *Neocoris* because it was not intended for more than one species, and the characters drawn for it would not include *Plagiognathus Bohemani*, which is now by us associated with *N. Scotti*.

* Flor's trinomial nomenclature, which Mr. Pascoe thinks is "rather difficult to explain," is easy to understand, as the first generic name is used in a collective or "family" sense, and the second as subgeneric. But the device is cumbrous, and especially inconvenient for quotation; the purpose intended would have been better served by a reference of the genera (or subgenera) to families (or subfamilies).

Microphysa, Westw., was rejected because the characters laid down were drawn only from the female of one species, differing greatly from the male, while those of *Zygonotus*, Fieb., included both male and female.

The remarks about *Hydrometra* and *Gerris* appear to be well founded, the majority of authors having overlooked the fact of the priority of Latreille's generic name *Hydrometra* for the species *stagnorum*. Even Burmeister has done so; for in a note under *Linnobates*, a genus he established for this species, he says:—"Die Aenderung des Gattungsnamens wurde dadurch nöthig, dass ich den Namen *Gerris* für die von Fabricius in diese Gattung gestellten Arten beibehalten zu müssen glaubte, da er das Recht der Anziennität für sich hat." *Hydrometra*, Lat., should be the generic name for *stagnorum*, and *Gerris*, Fab., be restored to the species of *Hydrometra* of authors.

In these remarks we have been careful not to travel beyond the record. The argument touches only a few points on the surface of a great subject (the real signification of genera), about which no two authors are agreed. The so-called "analytic method," for instance, so much in favour, tends to the infinite multiplication of genera; so that we are in danger of realizing the taunt of Curtis "that every species would constitute a genus," or of going a step further, and, by adopting Amyot's "système mononymique," which gives to every creature a new and single name, abolish genera altogether.

XXXVII.—*On the Muscular Anatomy of the Alligator.* By the Rev. SAMUEL HAUGHTON, M.D., F.R.S., Fellow of Trinity College, Dublin.

[Plate X.]

In the sixteenth volume of the 'Annals of Natural History' (3rd series, p. 326) I published an account of the muscular anatomy of the leg of the Egyptian Crocodile (1865). Since that time I have had an opportunity of studying the anatomy of the Alligator of the Mississippi (June 1866). The specimen dissected by me was a female, upwards of 6½ feet in length. Its examination confirms, in most respects, the conclusions at which I arrived from the dissection of the smaller specimen of Crocodile previously described; and I believe the results of my dissection are worthy of being recorded.

Mr. Hair, of Edinburgh, has kindly forwarded me a copy of a paper on the Alligator, read by him as a thesis in the Uni-

versity, which I have compared with my own results. I feel indebted to him for having corrected an error in my former paper on the Crocodile, in which I confounded the *glutæus minimus* with the *tensor femoris vaginae* muscle: this error has been avoided in the present paper; but I have adhered steadily to the other supposed errors pointed out by Mr. Hair, as he has failed to satisfy me that I am mistaken in my view of the true relations and names of the pelvic bones of the Alligator or Crocodile.

In Pl. X. fig. 1 is represented the pelvic arch of the Alligator (left side), in which the parts, as named by me, are—

Ischium	<i>Isch.</i>
Ilium	<i>Il.</i>
Marsupiale	<i>m.</i>
Pubes	<i>p.</i>

These bones are named by other anatomists as follows:—

<i>Isch.</i> + <i>Il.</i>	ilium.
<i>p.</i>	ischium.
<i>m.</i>	pubes.

The weight of evidence is altogether in favour of the names given by me, so far at least as the muscles are concerned, as will appear to any comparative anatomist from the following description, by which it appears that the usual origins are left to all the muscles, and that no difficulty occurs with respect to any muscle, except those named by me marsupiales (Nos. 44, 45), which would be called obturators by those who take a different view of the pelvic bones. On the other hand, however, such anatomists would be required to explain why the hamstring muscles should take origin from the ilium and not from the tuber ischii, and why the pectineus should arise from the anterior border of the ischium rather than from its classical origin on the pectineal line of the pubes.

Such questions, however, relate to transcendental anatomy, with which at present we have no concern; and I hope the description here given of the muscles, with their weights, origins, and insertions, will be sufficient to enable any other anatomist to recognize them readily.

I. *Muscles of the Hind Limb.*

1. *Sartorius.* 0·84 oz. av. O. from the anterior spine of the ilium. I. into the fascia of the inner side of the thigh, halfway down.

2. *Psoas magnus*. 3·67 oz. O. from all the lumbar vertebrae. I. into the outer trochanter, and, by a strong tendon, into the skin at the outer side of the thigh.

3. *Iliacus*. 1·20 oz. O. from whole inner anterior surface of the ilium and of the transverse processes of the anterior sacral vertebra. I. into the inner trochanter.

4. *Pectineus*. 0·89 oz. O. from the central anterior portion of the pubes, between the two heads of the *gracilis* muscle. I. into the upper part of the back of the femur.

5. *Adductor brevis*. 1·34 oz. O. anterior edge of pubes, behind origin of *pectineus*. I. into the middle two-fourths of the *linea aspera*.

6. *Adductor magnus*. 0·88 oz. O. from the posterior edge of the pubes, its middle third. I. into the lower half of the *linea aspera*, with a slip inserted into the joint tendon of the *gracilis* and *seminembranosus*.

7. *Obturator externus*. 0·44 oz. O. from the posterior edge of the pubes and from the obturator membrane joining that edge with the vertebrae behind the *tuber ischii*. I. into the back of the top of the femur, associated closely with the *pectineus* and with the *marcupiales*.

8. *Adductor longus*. 0·91 oz. O. from the posterior end of the *symphysis pubis*. I. into the back of the top of the tibia and having a fascial union with the tendon of the *semitendinosus*. It forms a spindle-shaped handsome muscle.

9. *Quadratus femoris*. 1·75 oz. O. posterior margin and inner surface of the ischium, and surface of the transverse process of the posterior sacral vertebra. I. into back of top of femur, and into the tendon of the *extensor femoris caudalis*.

10. *Obturator internus*. None.

11. *Agitator caudæ*. 0·97 oz. O. from the ilio-ischiadic crest, behind the origin of the *glutæus maximus*. I. by a double tendon, exactly as in the Crocodile (*Ann. Nat. Hist. ser. 3. vol. xvi. p. 327*).

12. *Glutæus maximus*. 1·98 oz. O. from the central two-fourths of the ilio-ischiadic crest. I. into the fascia outside and above the knee-joint.

13. *Pyriformis*. None.

14. *Glutæus medius*. 1·14 oz. O. from the central portion of the ilio-ischiadic surface. I. by a tendon passing over the outer trochanter to be inserted into a line down the upper half of the outside of the femur.

15. *Glutæus minimus*. None.

16. *Glutæus quartus*. None.

17. *Glutæus quintus*. None.

18. *Tensor vaginæ femoris*. 0·14 oz. O. from the anterior

spine of the ilium, near the articulation of the marsupial bone. I. into the fascia of the inner side of the thigh, near its middle.

19. Biceps femoris. 1·04 oz. O. This muscle has two origins ($a=0\cdot69$, $b=0\cdot35$), arising from two parts of the surface of the ischium, below and behind the origin of the glutæus maximus. I. as in the Crocodile (*ibid.* p. 327), except that it is partly inserted into the head of the outer gastrocnemius as well as into the peroneus longus.

20. Bicipiti accessorius. None.

21. Semimembranosus. 1·52 oz. O. tuber ischii. I. into the top of the tibia, by a common tendon with the gracilis.

22. Semitendinosus. 1·93 oz. O. tuber ischii. I. by means of a tendon having a double insertion:— a , into the top of the fibula; b , into the outer tarsal bone (cuboid) with tendon of the gastrocnemius.

23. Gracilis. 0·89 oz. This muscle consists of two parts:— a , 0·24 oz.; b , 0·65 oz.: a derives its origin from the posterior angle of the pubes; b arises from the anterior prominence of the pubes, close to the acetabulum and to the articulation of the marsupial bone with the pubes.

24. Rectus femoris. 0·77 oz. The origin and course of this remarkable muscle are the same as in the Crocodile (*ibid.* p. 327); its tendon finally terminates by becoming one of the heads of the plantaris.

25. Vastus externus. 1·01 oz.

26. Vastus internus } . 2·76 oz.

27. Crureus

28. Popliteus. None.

29. Gastrocnemius. 2·05 oz. Consists of two parts:— a , outer head, 1·29 oz.; b , inner head, 0·76 oz.: a derives its origin, as in the Crocodile, from the tendon of the great extensor femoris caudalis (Ann. Nat. Hist. ser. 3. vol. xvi. p. 328), and is inserted by a tendon passing in a groove under the calcaneum into the outer and under surface of the outer tarsal bone (cuboid): b derives its origin from the inner condyle of the femur and from the top of the tibia; the tendon of the inner head joins that of the outer head before it passes under the calcaneum; this tendon is also joined by that of the semitendinosus.

30. Plantaris. 0·47 oz. This muscle takes its double origin, as in the Crocodile (*ibid.* p. 328), from the tendons of the rectus femoris and agitator caudæ; and it is inserted into the calcaneum and into the fascial sheet that passes under it, which forms the origin of the flexor brevis perforatus of the second toe.

31. Soleus. None.

32. Flexor digitorum longus. 0·80 oz. O. usual. I. into the ungual phalanges of the first, second, and third toes only.

33. Flexor hallucis longus. 0·20 oz. O. from the back of the outer condyle of the femur, from the tendon of the extensor femoris caudalis. I. into the tendon of the flexor digitorum longus.

34. Tibialis posticus. 0·72 oz. This muscle is inserted into the near ends of the first and second metatarsal bones.

35. Flexor digitorum brevis. 0·76 oz. Consists of three distinct muscles, distributed to the second, third, and fourth toes: *a*, flexor 2^d digiti perforatus, 0·45 oz.; *b*, flexor 3^d digiti perforatus, 0·20 oz.; *c*, flexor 4th digiti perforans, 0·11 oz. The flexors *a* and *b* are perforate flexors, and are distributed to the penultimate phalanges, while flexor *c* is carried on to the ungual phalanx, and supplies the office of the flexor longus, which is wanting in the fourth toe. The flexor brevis of the second toe (*a*) takes its origin partly from the calcaneum and partly from the tendon of the plantaris.

36. Flexor longo accessorius. 0·34 oz. O. from the calcaneum and cuboid bones. I. into the back of the common tendon of the flexor digitorum longus, which is distributed to the first, second, and third toes only.

37. Tibialis anticus.

38. Extensor hallucis.

39. Extensor digitorum longus.

} 1·22 oz.

O. from the tibia and fibula, and by means of a long tendon from the anterior surface of the outer condyle, inside the knee-joint.

40. Peroneus tertius. 0·15 oz. The tendon of this muscle crosses the back of the foot to be inserted into the metatarsal of the first toe.

41. Peroneus brevis. 0·17 oz. Inserted into the outer side of the outer tarsal bone (cuboid and rudimentary fifth metatarsal).

42. Peroneus longus. 0·40 oz. Takes its origin from the fibula, and is closely associated with the outer gastrocnemius.

43. Extensor femoris caudalis. 14·55 oz. This important muscle is similar to that found in the Crocodile (*ibid.* p. 328), and derives its origin from the under surfaces of the transverse processes, and from the sides of the inferior spinous processes (*chevron* bones or hæmal processes) of the caudal vertebræ, from the first to the fifteenth.

N.B. The first *chevron* bone begins at the junction of the second and third caudal vertebræ.

44. Marsupialis externus. 1·05 oz.

45. *Marsupialis internus*. 0.59 oz.

These muscles agree with those described under the same name in the Crocodile (*ibid.* p. 330); and they are called obturator muscles by those anatomists who consider the marsupial bone to be the pubes.

46. *Peroneo-calcaneus*. 0.22 oz. O. from the fibula, at its lower extremity. I. into the upper surface of the calcaneum.

47. *Extensor brevis*. 0.87 oz. These short extensors are distributed to all the toes.

48. *Lumbricales*. 1.13 oz.

II. Muscles of the Fore Limb.

a. *Trapezius*. 0.33 oz. O. from the cervical fascia beneath the cervical scutes. I. into the anterior edge of the acromion, (Pl. X. fig. 2, *acr.*).

b. *Sterno-atlanticus*. 1.46 oz. O. from the whole breadth of the sternum, in front of its articulation with the coracoid. I. into the transverse process of the second cervical vertebra.

c. *Sterno-mastoideus*. Record lost.

d. *Omo-hyoideus*. 0.36 oz.

e. *Rhomboideus**. 0.45 oz. O. from spinous processes of last cervical and first dorsal vertebra. I. anterior and vertebral edge of scapula.

f. *Serratus magnus*. 4.14 oz.

Serratus anticus has its origin from the second to the eighth vertebra.

Serratus posticus from the ninth to the fourteenth vertebra (ribs).

1. *Teres major*. 0.18 oz. Origin and insertion as usual.

2. *Latissimus dorsi*. 0.95 oz. O. from the four anterior dorsal scutes.

3. *Subscapularis*. 0.84 oz.

4. *Pectoralis minor*†. 0.57 oz. O. from the outer surface of the coracoid.

5. *Pectoralis major*. 7.68 oz. O. from the entire length of the sternum and from the abdominal ribs, two-thirds of distance to the pelvis.

6. *Pectoralis (avium)?* 0.90 oz. O. from the first sternal rib. I. into the posterior edge of the coracoid.

7. *Coraco-brachialis*. None.

8. *Subclavius*. None.

9. *Deltoides*. 1.63 oz. O. from the whole outer and

* Meckel describes the rhomboid as smaller than the trapeze.

† This muscle is regarded by some as a coraco-brachialis superior.

inner surfaces of the acromion, winding out from the inner surface to join the outer portion of the muscle.

10. Supraspinatus. 0·28 oz.

11. Infraspinatus*. None.

12. Teres minor. None.

13. Infraspinatus secundus. None.

14. Biceps humeri (scapularis). None.

15. Brachiaëus. 0·51 oz. The brachiaëus muscle consists of two distinct portions:—*a*, brachialis externus, 0·24 oz.; *b*, brachialis anticus†, 0·27 oz.: of these the portion *a* is inserted into the radius, outside the insertion of the biceps; and the portion *b* is inserted into the radius, with the tendon of the biceps.

16. Biceps humeri (coracoidalis). 0·46 oz. O. from the anterior edge of the coracoid, near the glenoid cavity. I. by a common tendon with brachialis anticus, into the radius.

17. Triceps longus‡. 1·67 oz.

18. Triceps internus.

19. Triceps externus.

20. Triceps accessorius. } 1·35 oz.

21. Anconæus.

22. Pronator radii teres§. None.

23. Flexor carpi radialis||.

24. Palmaris longus. } 0·53 oz. Inserted into the

tendon of the flexor digitorum, in the centre of the palm.

25. Flexor carpi ulnaris. 0·65 oz. Inserted into the pisiform bone.

26. Flexor digitorum sublimis.

27. Flexor digitorum profundus. } 0·31 oz.

28. Flexor pollicis longus.

* Meckel describes the infraspinatus as distinct from the supraspinatus. I could not separate them, either in the Crocodile or Alligator.

† Meckel regards this muscle as a second head of the biceps.

‡ The triceps muscle, although it possesses no accessory cutaneous slip arising from the latissimus dorsi, yet has four heads, viz. :—

a. Triceps longus; from the posterior edge of the scapula, close to the glenoid cavity.

b. Triceps longus secundus; from a sling tendon suspended between the posterior edges of the scapula and coracoid, allowing the subscapularis to pass between the tendons.

c. Triceps externus; as usual.

d. Triceps internus; as usual.

§ Meckel describes two supinators and two pronators in the forearm of the Crocodile: I found one only of each in the Crocodile and in the Alligator.

|| This muscle may be the palmaris longus, or, possibly, the flexor pollicis longus: its tendon is inserted, laterally, into the broad tendon of the flexor digitorum communis in the centre of the palm of the hand; and its force is expended chiefly on the thumb, index, and middle fingers.

29. Pronator quadratus*. 0·43 oz.
30. Supinator radii longus*. 0·42 oz.
31. Extensor carpi radialis longior. 0·17 oz.
32. Extensor carpi radialis brevior. 0·16 oz.
33. Supinator radii brevis*. None.
34. Extensor digitorum longus (*qu. ext. oss. metacarpi pollicis*). 0·10 oz.
35. Extensor carpi ulnaris. 0·24 oz.

III. *Muscles of the Jaws and Head.*

Herodotus and Aristotle state that the Crocodile, alone, moves the upper jaw, while other animals move the lower jaw. This statement is borne out by the muscular anatomy of the animal, which is capable of opening its mouth by lifting the upper jaw and head while its lower jaw rests upon the mud of the bank on which it lies.

A. *Aristotelis apertor oris*. 1·34 oz. O. from the *upper* surface of the posterior process of the angle of the lower jaw. I. into the outer fourth of the occipital ridge.

B. *Pterygoideus (clausor oris)*. 17·90 oz. O. from the *under* surface of the posterior process of the angle of the lower jaw. I. into the back of the pterygoid plate and all round the floor of the orbit of the eye, forward.

C. *Masseter*. 4·90 oz.

D. *Cervico-spinal occipital (α)*. 3·30 oz. O. from the tips of the spinous processes of all the cervical vertebræ. I. into and below the occipital ridge.

E. *Cervico-spinal occipital (β)*. 2·32 oz. O. from the sides of the spinous processes of all the cervical vertebræ. I. into the occiput, below the insertion of the last (α).

IV. *Comparison of the Pelvic and Scapular Muscles.*

The plane of motion in which any muscle moves a bone round the joint is defined by three points:—

- O. The origin of the muscle.
- I. The insertion of the muscle.
- C. The centre of motion of the joint.

The point I varies as the limb changes its position, while the points C and O remain absolutely fixed in the pelvis, and comparatively fixed in the shoulder or scapular joint. The lines joining (C) the centre of the joint with the points (O)

* See note §, *anted.*

belonging to the various muscles thus mark out *fixed lines* round which the planes of muscular *momentum* must turn in every conceivable position of the joint.

If we compare together the positions of these fixed lines in the pelvic and scapular joints, we may readily obtain relations between the muscles of the hind and fore limb that would escape notice unless so examined, and which seem to possess much interest.

Let us commence with the pelvic joint (Pl. X. fig. 1), and take for the zero of our circle described round the centre of the joint the plane of the rectus femoris, tensor vaginæ femoris, and sartorius, which corresponds with the plane of flexion of the knee-joint.

Following from *right to left* (on left side of pelvis) the order of muscles, we obtain the following table:—

<i>Pelvic Joint.</i>			Weight.	Azimuth.
1.	{ Sartorius Rectus femoris Tensor vaginæ femoris }	.....	1.25 oz.	0°
2.	{ Psoas Iliacus }	.....	4.87 oz.	23°
3.	{ Marsupialis externus Marsupialis internus }	.....	1.64 oz.	45°
4.	{ Gracilis Pectineus Adductor brevis }	.....	3.22 oz.	106°
5.	{ Adductor magnus Adductor longus }	.....	1.79 oz.	125°
6.	Obturator externus	.....	0.97 oz.	149°
7.	{ Quadratus femoris Extensor femoris caudalis }	.....	16.30 oz.	194°
8.	{ Biceps femoris Semitendinosus Semimembranosus }	.....	4.49 oz.	217°
9.	{ Glutæus maximus Glutæus medius Agitator caudæ }	.....	4.09 oz.	266°
Total..			38.62 oz. av.	

In the preceding table I have reckoned gracilis in the same azimuth with pectineus and adductor brevis, because the resultant of its two heads lies in this line.

The fixed lines of the muscles of the shoulder-joint, commencing with the triceps longus, which is in the plane of motion of the elbow-joint, from *left to right* (on left side of shoulder), may be arranged as follows:—

Shoulder-Joint.

	Weight.	Azimuth.
1. Triceps	3.12 oz.	0°
2. Teres major	0.18 "	2°
3. { Latissimus dorsi	0.95 "	14°
Subscapularis	0.84 "	346°
4. Pectoralis major	7.68 "	129°
5. Pectoralis minor	0.57 "	190°
6. Biceps humeri	0.46 "	258°
7. Deltoideus	1.63 "	310°
8. Spinati	0.28 "	342°
Total..... 15.71 oz. av.		

The resultant *moment* of latissimus dorsi and subscapularis passes through a line coinciding almost exactly with the line of teres major; and these three muscles are intimately associated in their action.

If we arrange the pelvic and scapular muscles in parallel columns according to their admitted relationships, we shall obtain the following comparative table:—

Comparison of Pelvic and Scapular Muscles.

Pelvic Muscles.		Scapular Muscles.	
1. { Rectus femoris }	0°	1. { Triceps humeri.....	0°
Sartorius		Teres major	2°
Iliacus	23°	Subscapularis	—14°
2. { Psoas magnus }	45°	Latissimus dorsi	+14°
3. { Marsupiales }	106°	2. Wanting.	
Gracilis			
Pectineus			
3. { Adductor brevis }	125°	3. Pectoralis major	129°
Adductor magnus			
Adductor longus			
4. Obturator externus	149°	4. Wanting.	
5. { Quadratus femoris }	194°	5. Pectoralis minor	190°
Ext. fem. caudalis			
6. { Biceps femoris }	217°	6. Biceps humeri	258°
Semitendinosus			
Semimembranosus			
7. Glutæi	266°	7. { Deltoideus	310°
		Spinati	342°

Many important deductions might be made from the pre-

ceding table; but I shall content myself with indicating the following:—

1. The analogous muscles in the hip-joint and shoulder-joint of the same side of the body are arranged in reverse order—thus confirming the opinion of Vicq d'Azyr that the left leg should be compared with the right arm, and *vice versa*.

2. The marsupial muscles in no respect correspond with the obturators, but find their true analogues in a muscle whose direction lies between that of latissimus dorsi and the pectorals. This muscle (wanting in the Alligator and Crocodile) is found in the following animals:—the Armadillo, the Seal, the Otter, and other animals that dig or swim.

3. The analogue of the obturators is found in the second pectoral of the birds, which acts as a levator humeri, and whose line of direction lies between the pectorals. This muscle may *possibly* be represented in the Crocodile and Alligator by the pectoral muscle extended from the first sternal rib to the posterior edge of the coracoid.

XXXVIII.—On the peculiar Structure and Function of the *Spicules of Hyalonema*. By Dr. J. E. GRAY, F.R.S., V.P.Z.S., F.L.S., &c.

ONE of the chief reasons assigned for regarding the rope-like axis of *Hyalonema* as part of a Sponge, to which some specimens have been found attached, is that it consists of spicules which are composed of silica, and formed like the spicules of sponges. Prof. Max Schultze, Prof. Wyville Thomson, and others compare them with the long filiform spicules of *Euplectella*.

Zoologists and microscopists have overlooked the importance of a very marked peculiarity in the formation of the spicules of *Hyalonema* that is not to be observed in the spicules of any kind of Sponge that I have examined or seen figured. This is the more remarkable as the peculiarity to which I refer was mentioned when I first described the genus, and is figured by Max Schultze, Brandt, and Bocage, and, indeed, by all authors who have figured the genus; but these authors have not considered why the peculiarity existed and the bearing it has on the question of the structure of the animals to which the spicules belong.

The spicules of Sponges are formed of a number of concentric layers round a central line, and they always have a perfect, more or less acute end, which is simple and formed of

coats like the rest of the body; in fact they seem to be increased in size by a layer of siliceous and animal matter being deposited on their whole surface, on the apices as well as the rest of the body.

On the contrary, the spicules of *Hyalonema* are subcylindrical, rather thicker above, and very slender at the base, formed of numerous concentric laminae round a central line; but the outer layers do not reach the ends of the spicules. The ends are truncated, and there is a succession of laminae, each terminating shorter and shorter of the top of the spicules; so that the ends of the spicules are furnished with a succession of rings, each formed by the termination of a layer of siliceous and animal matter, as is well figured in the plates of Professors Max Schultze, Brandt, and Bocage.

I believe that this difference in the structure arises from the very different functions which the spicules of the axis of *Hyalonema* have to perform in the coral from those for which the spicules of the sponges are formed in the body of those beings. In *Hyalonema* the coral is gradually being extended in height, and the spicules are extended in length, *pari passu*, to support the coral as it grows. To allow of this extension of length, the ends of the spicules are not finished off as they are in the sponges, where they are completed at once, and are only slightly thickened and lengthened to a certain limit as the sponge grows. The spicules of sponges merely form a support for a more or less massive sponge, and are of a definite size; while the spicules of the rope-like axis are continually increasing in length and thickness to support a continually growing mass of animals, which require a larger and stronger axis to support them as the community assumes the adult form. The spicules of the rope-like mass are of different thickness; and they increase in number as the axis increases in diameter, those last formed being the most slender and consisting of the fewest concentric layers.

It is to be observed that the short rugose cruciform spicules in the bark* of the *Hyalonema*, which do not require to be lengthened as the coral increases in size, are formed like the spicules of sponges, and are complete in form when first deposited, and have complete ends. This difference in the structure of the spicules of the axis and of the bark, I think, goes far to confirm the theory I have propounded, that the spicules of the axis are of different structure, because they have a peculiar function to perform.

This peculiarity in the structure and function of the spicules of the axis, I think, proves that they are no part of the sponge, but a secretion of the hard flesh of the polype that surrounds

each of them and forms the mass of them, and that they are a part of the community of the *Palythoa*, and not a mere bundle of spicules arising out of the sponge.

If I understand the theory of those who regard the rope-like axis of *Hyalonema* as the spicules of a sponge, they believe that the spicules of the sponge are clustered together in the centre of the sponge, and are produced, forming an elongated columnar coil, which, according to Bowerbank, is covered with a skin forming part of the sponge, and according to Professors Brandt and Max Schultze is covered with a coat of parasitic *Palythoa*. If either of these theories is true, the spicules should be of the same form and structure as the spicules of sponges, and complete and acute at each end.

I have shown that the spicules of the coil are not formed as the usual spicules of Sponges, but have their ends, and especially their upper or distal ends, always in an incomplete state of development, and that they are constantly being lengthened by the addition of coats to the end of each of the layers of which the spicules are composed. I think we may conclude that the spicules are produced or secreted by the coat of corium that covers them (and this coat has, I think, been most indisputably proved to be formed by the community of animals allied to *Palythoa*), and therefore that the axis is not a part of the sponge, but the proper secretion of the *Palythoan* animals.

Prof. Max Schultze, though he figures this structure (t. 2. f. 4 & 5), appears not to understand its importance; for he compares it to a fusiform spicule with a central spherical knob that he found in the sponges which are furnished with some spines which are directed towards the centre. But this is evidently only a variety (and one I have not seen) of the stellate spines figured on tab. 4. f. 2, 4, 7, 8 & 9, though in these the spines on the rays are all directed towards the tips. These spinulous spicules are all perfect and acute at the tips, and are not truncated and growing at the end like the spicules of the coil of *Hyalonema*.

Prof. Brandt's figures of the spicules of *Hyalonema*, on tab. 2. f. 12, 13, 14, & 15, much more accurately represent the structure; but it is to be remembered that figs. 12 & 13 represent wrong ends of the spicule upwards; that is to say, the slender end of the spicule is the one that is immersed in the sponge, and the blunt truncated lower end, as it appears in these plates, is the end of the spicule that is furthest from the place of attachment and which is being extended to accommodate itself to the increased height of the bark or community of polypes. And tab. 4. f. 14 also well represents the coat of which the spicules

are composed, and the sheath of fleshy matter or corium with which each is surrounded. The existence of this sheath, which is of the same structure and substance as the inner layer of the bark, I have always regarded as a proof that the spicules were formed by the community of *Palythoe* that compose the bark or corium.

The long free filamentous spicules of the *Euplectella*, which are regarded by Dr. Max Schultze and Prof. Wyville Thomson as most resembling in form the spicules of the axis of the *Hyalonema*, have an acute simple tip, or have the tip armed with three or more recurved hooks, as figured by Bowerbank. It is curious how Dr. Max Schultze, who has figured the peculiar structure of the spicules of *Hyalonema*, and must have seen the spicules of the *Euplectella* furnished with hooks, could have thought of uniting the two genera into a group, which he called *Lophiospongiæ*; for nothing can be more distinct than the structure, form, and use of the spicules of these two genera belonging to orders of animals of such different degrees of organization.

BIBLIOGRAPHICAL NOTICES.

Coleoptera Hesperidum, being an enumeration of the Coleopterous Insects of the Cape Verde Archipelago. By T. VERNON WOLLASTON, M.A., F.L.S. 8vo. London: Van Voorst, 1867.

How far Mr. Wollaston is warranted in applying the term *Hesperides* to the southernmost cluster of the North Atlantic islands is a question which we must leave to the classical student for decision; perhaps they have as good a right to the title as any others. But to the entomologist, since the publication of the book whose title is given above, the *Hesperides* will most certainly be identified with the Cape Verde Islands, seeing that Mr. Wollaston's visit to them has enabled him to present his brother entomologists with a treasure of higher value than any amount of golden apples ever guarded by the most terrible of dragons.

The materials for the '*Coleoptera Hesperidum*' have been chiefly collected by Mr. Wollaston himself, during a visit to the little archipelago in Mr. Gray's yacht. Mr. Gray, Mr. Hamlet Clark, and Mr. Lowe had also previously landed on some of the islands; and Mr. Wollaston acknowledges the receipt of specimens from some other gentlemen; but the arid nature of the group, in some of the islands of which rain scarcely ever falls, renders the most careful working unproductive, and accordingly the whole number of species obtained from all sources amounts only to 278. This number might perhaps be slightly increased by an investigation of the three eastern islands of the group, which Mr. Wollaston did not visit; but the very name of "*Salt Islands*" applied to these seems to indicate that pro-

bably no great results would be obtained from them. The materials at Mr. Wollaston's disposal were, however, sufficient to bring out some very interesting results.

The first of these is, that the relative proportions of the different great groups of Coleoptera in these remote islands is nearly the same as in the more fruitful regions of the Madeiran and Canarian groups, with the exception that the Heteromera and Rhynchophora exactly change places in the series, and that the Eucerata (Longicorns) are, as far as our author is aware, entirely unrepresented. The comparative inferiority of the Rhynchophora may perhaps be due, as Mr. Wollaston seems to think, to the improvident destruction of the timber by the inhabitants; and the same cause would also, to a great extent, account for the absence of the Longicorn Beetles. Considering the arid nature of the islands, it is a little remarkable that whilst the Philhyrida and Hydradephaga hold the same relative position in the numerical scale, their actual proportion to the whole number of species is greater in the Cape Verde than in the more northern islands; for we have 7 Hydradephaga and 6 water-loving Philhyrida in the former, against 29 and 20 in the latter, the totals being about in the proportion of 28 to 145.

Nor is it only in these statistical results that the two sets of islands, which Mr. Wollaston has subjected to examination, agree; even the exponents of Coleopterous groups, although not very frequently identical, are generally so nearly allied that Mr. Wollaston seems to think that it would be most natural to regard the fauna of all the islands as forming a whole, differing in certain details in the more distant islands, but characterized throughout by a similarity of type. Thus, although the predominance of Heteromera would seem at first sight to indicate that nearer African relationship which might be inferred from the position of the islands, we find on inspection of the list that the types are, for the most part, like those of the more northern islands. It is to be observed, however, that, notwithstanding this similarity of the types which are represented in the Cape Verdes to those prevailing in the more northern clusters, Mr. Wollaston remarks upon the total absence in the former of types highly characteristic of the latter. This, however, as he points out, is probably the result of distance, assisted perhaps by the breaking up of the province into such a number of small islands.

Of truly tropical forms Mr. Wollaston enumerates only three, namely, *Dineutus cereus*, *Diplognatha gagates*, and *Aspidomorpha cincta*.

Of the species enumerated by Mr. Wollaston a great number seem to occupy the same position in relation to other known species which characterized so many of those catalogued by him in his former work; that is to say, they differ so slightly that, but for the difference of habitat, they would perhaps hardly be regarded as species. All these are carefully indicated by Mr. Wollaston in his geographical table by means of arrows leading to the name of the probable derivative species; and it will be a task for some Darwinist hereafter to work carefully over Mr. Wollaston's indications of this

nature, and to see whether any real material towards the final solution of the great question of the origin of species can be derived therefrom. Mr. Wollaston, in accordance with his known views, holds that these changes (if such have taken place) will have been effected rapidly. Whatever conclusion may be arrived at upon this subject, no one will doubt that in his present work and its companion, the 'Coleoptera Atlantidum,' Mr. Wollaston has furnished a most important contribution to philosophical zoology.

Naturhistorisk Tidsskrift (Journal of Natural History), edited by Professor J. C. SCHIÖDTE, at Copenhagen. Third Series, vols. iii. & iv. (1865-1867), 568 pages with 15 plates, and 552 pages with 22 plates.

J. C. SCHIÖDTE on Phthiriasis; on the genus *Stalita*; on the Classification of *Buprestes* and *Elatères*; on some Tunnelling Coleoptera; on the Structure of the Mouth in Sucking Crustacea, and on the Metamorphoses of Coleoptera.—Dr. R. BERGH, Contributions to a Monograph of Pleurophyllididae.—Dr. V. BERGSÖE on *Philichthys Xiphie*, St.; on the Italian *Tarantula* and Tarantism.—Dr. BERGSÖE and Dr. MEINERT on the Danish Species of *Geophili*.—Dr. MEINERT on Campodæ; on *Miastor metraloas* (three articles).—M. FISCHER on the Egg of *Caryocatactes guttatus*; on *Larus Rossii* and on *Syrphaptes parulozus*.—M. STRÖM on the Danish Species of *Orygia*; List of Danish Lepidoptera.

THE third and fourth volumes of this periodical, which have just been completed, are in every way worthy of their predecessors, which were noticed in the 'Annals' (ser. 3. vol. xv. p. 475). They consist entirely of original papers by Danish naturalists, and are admirably illustrated by engraved plates. Several of the papers above mentioned have been translated or excerpted in English or other continental periodicals. Prof. Schiödte's papers on Phthiriasis, *Elatères* and *Buprestes*, tunnelling Coleoptera, and sucking Crustacea have been translated in the 'Annals,' as well as Dr. Meinert's papers on Campodæ and his observations on those remarkable larvæ of *Coccidomyia* which exhibit alternating generations, and on generation generally; whilst M. Fischer's discovery of the true egg and nest of *Caryocatactes* has been communicated to English ornithologists through the 'Ibis.' But there remain several papers well worthy of attention.

The volumes before us contain two further instalments (vol. iii. p. 131, and vol. iv. p. 415) of Prof. Schiödte's memoir "De Metamorphosi Eleutheratorum Observationes," which has now grown up to 279 pages of text and 31 plates, and is still being continued. The larvæ as yet described amount to 100, belonging to 57 genera of the families of Carabi, Dytisci, Gyrini, Hydrophili, Silphæ, Histri, and Staphylini, and representing the principal groups of these families, except the last, which is not yet completed. A few of these larvæ have been described before, but mostly in loose and general terms; and it may well be said that never have the larvæ of any insects been the subject of such complete and accurate investigation

and illustration. Almost everything in this memoir is therefore new; and it would be so much the more difficult to make a suitable extract from the host of new observations, as, in spite of the great mass of detail, nothing has been included in the descriptions but what really has scientific value. It is an exceedingly difficult task, in commencing the study of a new branch, to limit properly the detail to be inserted in the descriptions, because experience alone can show what has systematic and philosophical value, and what not. But in the memoir before us the matter seems to have been prepared so long and weighed so carefully that there is nothing superfluous, nothing that does not really serve to complete our conception of the animals. One question, however, may fairly be asked, viz., What light do these investigations throw on the systematic relations of the families to which the larvæ belong? And a few leading results may easily be pointed out. The new division of the family of Carabi, proposed by Prof. Schiödte some years ago (*Ann. Nat. Hist. ser. 3. vol. x. p. 380*), and based on the development of the epimera metathoracica and the position of the antennæ &c., is fully borne out by the larvæ, particularly the union of Carabini, Elaphrini, and the anomalous genus *Loricera*, Latr., into one natural group. The close relationship of Carabi, Dytisci, and Gyrini, which form such a well-defined group at the head of the order, finds an expression in the fact that their larvæ possess true, almost invariably double, claws, with proper apparatus of muscles, whilst the larvæ of all other families have only a "tarsus unguiformis." The union of Silphæ and Anisotomæ is also strongly supported by the similarity of the larvæ; and the received division of Dytisci and Hydrophili into groups is likewise most markedly expressed in the larvæ. The larvæ of Haliplini are distinguished from those of the other groups not only by their dorsal segments being armed with spines, which gives them a very grotesque appearance, but by their possessing only one claw, whilst all others have two, and by their anal segment (which is rudimentary in all other Dytisci) being enormously elongated and bifurcate, so that the anus is placed on the underside of this peculiar tail, and the spiracles of the eighth pair, which are terminal and tubiform in other Dytisci, here become lateral and quite plain. The larvæ of Hydroporini are all distinguished by the production of their forehead so as to form a kind of horn, against the under surface of which the mandibles, being very long and curved upwards, work, whereby they are enabled to keep their prey very firm while sucking it out; they are also swift swimmers, thanks to the shape of their body and their (usually) ciliated legs. Then follow the well-known larger larvæ of *Dytiscus*, with large, free, round heads, narrow prothorax forming a kind of neck, and ciliated abdomen. Still greater variety is met with amongst Hydrophili, beginning with the amphibious larvæ of *Helophorus* (which catch their prey running), whose lateral abdominal appendages are stiff and adapted for supporting their crawling movements, and who are also destitute of the peculiar hairy or felty covering which enables the larvæ of *Hydrophilus* and others to carry with them a supply of air surrounding their

body when diving, instead of which the peritreme of the spiracles in *Helophorus* is dilated and so arranged that a small quantity of air will adhere to it. In the larvæ of *Hydrophilus* the lateral appendages of the abdomen are soft, flexible, ciliated, and assist in buoying up the heavy fleshy body of the larva (for which purpose even the antennæ are ciliated); but they do not serve for respiration as in the larvæ of *Berosus*, where they form true branchiæ of considerable size. In this last genus the terminal (eighth abdominal) pair of spiracles, which in the family of Hydrophili are usually very large and lead into a capacious air-chamber, are accordingly very minute, and the air-chamber is wanting. In the larva of *Hydrous* these lateral appendages are very small; and they are entirely wanting in the larvæ of *Hydrobius* and of *Philhydrus*, which simply walk about on submerged objects, the latter even assisted by five pairs of abdominal feet. In the larvæ of *Cereton* and *Sphæridium*, which represent the Hydrophiline type modified for life on dry land (though in humid places), we find neither lateral abdominal appendages nor even true feet, the animal wriggling its way through the debris amongst which it lives, whilst the last abdominal segment is the largest of all, and often armed with hooks. In the family of Staphylini a remarkable division presents itself, separating the family into two main parts,—one of which comprises the typical forms of the family, the group of Staphylinini; whilst the other embraces all the remaining groups, of which, however, only Oxytelini find a place in the portion of the memoir as yet published. But regard to space forbids our extracting more details or entering upon the general considerations which are largely suggested by the contents of this memoir, of which the above gives but a very inadequate idea; and we shall only add that nothing can be more varied than the succession of beings represented on the plates, or more instructive than the mode in which the author has handled the enormous mass of new and interesting details which he has observed.

In his present paper on *Stalita* (vol. iii. p. 70), Prof. Schiödte recurs to an observation made by him in a paper on the classification of Cerambyces, in Nat. Tids. ser. 3. vol. ii. p. 483 (Ann. & Mag. Nat. Hist. ser. 3. vol. xv. pp. 182, 183), to the effect that Arthropoda exhibit analogous variations with regard to the manner in which they tread the ground to those observed amongst Vertebrata, especially Mammalia; so that amongst them, too, we find plantigrade, digitigrade, and unguligrade groups, which are distinguished by analogous modifications in the development and outer appearance of the different parts of the limbs. "The true key," says he, "to the differences in structure between the leg of an insect and that of a spider, to the manner in which the respective divisions of the leg participate in the building up of the limb, and to their relative position, size, and shape, lies in the circumstance that spiders are digitigrade. If we thoroughly appreciate this, we shall also admit that the nomenclature now in use is faulty. In order to enable the spider to tread on the under surface of the point of the foot; that part of the leg which is outside and below the knee re-

quires several inward bends; and in order to give the movement the necessary softness and elasticity, without detriment to the carrying-power of the limb, these bends must follow each other with short intervals near both extremities of this line (*i. e.* just below the knee and near the point of the foot). This arrangement therefore necessitates that the first division under the knee should be much shorter in spiders than in insects; for whilst in insects, being plantigrade, this division constitutes the only lever for carrying the weight of the body, it forms in spiders, which are digitigrade, only the uppermost section of a compound lever, consisting of a succession of joints, each carrying a part of the burden. But this first division below the knee is the tibia, and it ought not to change name only because its size and the manner in which it enters into the composition of the leg are changed. That division of the leg, therefore, which araneologists call 'patella' is the true tibia, and what they call the tibia is the first joint of the tarsus lifted up from the ground." That is to say, Prof. Schiödte proposes that we should cease making a mistake with regard to spiders similar to that popularly committed with regard to horses and other Mammalia, whose wrists are called knees, and whose so-called shanks are merely the metacarpal portion of the foot raised from the ground and simulating a tibia. The genus *Stalita* was first established by Schiödte in his 'Specimen Faunæ Subterraneæ,' in which he described a series of remarkable Insects, Arachnida, and Crustaceans, discovered by him in the caves of Adelsberg in 1845, and wonderfully adapted in conformity with their life in darkness and on the stalactites. Since then, the cave-fauna has been carefully studied, without, however, adding much to our knowledge. The present paper on *Stalita* has been caused by a memoir of Count Keyserling in the 'Transactions of the I. R. Zoological and Botanical Society of Vienna' for 1862, on a new cave-spider (*Hadites tegeraria*) from Lessina, in Dalmatia, in which the author, having also received some female *Stalitas* from that locality, submits Schiödte's original account of *Stalita* to a severe criticism. Alluding to two figures in the Spec. Faun. Subt., viz. fig. 3 *c* and fig. 3 *d*, pl. 2, he says that they are intended to represent the same parts of the mouth in the two sexes of *Stalita tegeraria*, but that the difference is so great that Schiödte must have confounded two species. He regrets that Schiödte has not described the female, but only figured some parts of its mouth; and, on the supposition that his own *Stalitas* from Lessina belong to the same species as Schiödte's from Adelsberg, he proceeds to give what he thinks a more accurate description of these animals than is found in the 'Spec. Faun. Subt.' Unfortunately for his criticism, a reference to the figures in question shows that they represent, not the same, but utterly different parts of the mouth of the two sexes of *Stalita tegeraria*, fig. 3 *c* being described as "maxilla femineæ dextra cum labro palpoque maxillari, supra, decies aucta," and fig. 3 *d* as "maxilla maris sinistra, cum labio sternali inferne visa, sedecies aucta;" that is to say, one represents the upper lip from above in the female, the other represents the lower lip of the male from beneath, as indeed an able araneo-

logist ought to have seen even without reference to the explanation. There is consequently not the slightest vestige of the alleged confusion on Schiödte's part; and the Latin description of *S. tænaria* comprises evidently both sexes, which, apart from the ordinary sexual differences expressly referred to, are exactly alike. Nor can there be much doubt, if Count Keyserling's description be correct, that his specimens from Lessina belong not to *S. tænaria* as he thinks, but to a new and different species. Count Keyserling's new account of *Stalita* is therefore only calculated to create considerable confusion; and his considerations on the relations of *Stalita* to other genera are not without grave errors. He says, for instance, that *Stalita* differs from *Dysdera* by having three foot-claws, and by the palpi of the female terminating in a claw. But neither *Stalita* nor any other genus of Arthropoda has really three claws, though the claw-shaped onychium may give it such an appearance at first sight, as remarked by Schiödte in his first memoir; in *Dysdera* the onychium is soft, round, and hairy. Nor does the female *Dysdera* lack a terminal claw on its palpi, though Count Keyserling may have overlooked it. The last-named author also mentions as remarkable that the patellæ are much elongated in *Stalita*, the fact being, however, on the contrary, that, whilst all the other parts of the limbs are much elongated in *Stalita*, the patellæ do not participate in this modification, but remain comparatively short; and it is by way of showing the reason of this circumstance that Prof. Schiödte enters upon the general considerations above quoted.

The family of Geophili is easily distinguished from the other families of Chilopoda; but, although there is in reality no lack of good distinctive characters for genera and species, the attempts hitherto made at a natural classification of its contents have not been successful; and the authors of the paper on Danish Geophili (iv. p. 81), Dr. Meinert and Dr. Bergsøe, have been able to suggest very considerable improvements. We refer for details to their Latin diagnoses; but some general remarks may not be unacceptable. They derive good systematic characters not only from the organs of the mouth (with regard to which they follow Savigny's nomenclature), but also from the composition of the head. For species living more on the surface, firmer and more completely chitinated integuments are necessary than for those which are constantly hidden under stones, fallen leaves, &c.: accordingly it is found that in some the skull consists of one piece only, but in others it is divided into two pieces, a crown piece and a smaller front piece. Generally the posterior margin of the skull reaches the tergum of that segment which carries the second pair of maxillary feet (segmentum basilare, Newport), and even covers the anterior margin of that segment; so that the tergum of the intervening segment, which carries the first pair of maxillary feet, is entirely hidden from view. But in *Scolioplans*, a new genus, this generally hidden segment is quite free, and its tergum even divided into two plates more or less widely distant from one another. The number of the legs is a useful character, though it varies within certain limits. In males the average num-

ber of pairs of legs is always two less than the average number of pairs in the females. The number of pairs, counting the anal pair, is invariably uneven, and all variations, according to species, sex, variety, are produced by subtraction or addition of an even number. The authors consider it settled beyond doubt that the young *Geophili* at once possess the full number of segments and legs: not only have quite young specimens taken with their mothers presented the same number as the adult, but such specimens just hatched have been observed with a greater number of legs than is generally found in the adult. The pores of different kinds—ventral pores (on the ventral segments), the pleural pores (on the pleurae of the last joint which carries limbs), and the anal pores (on the last protruding apodal segment)—also afford good characters; but their number increases considerably as the animals grow in size. The colour is of very little value; the designs produced by the intestines shining through the integuments vary according to the state of feeding; and the intensity of the usually darker colour of the claws depends principally on the time which has elapsed since the last moulting. The length of the body and of the antennæ is not without importance, but varies according to the mode in which the animal is killed and preserved; and the characters derived from the shape of the individual joints are by far more valuable. The authors propose a new genus, *Scnipæus*, distinguished from *Geophilus* by the absence of anal pores, by having a smaller toothless claw on the first pair of maxillary legs, a larger second pair of maxillæ, thicker anal limbs in the male, and by the skull-plate being divided. They enumerate five species of *Geophilus* as Danish, of which one is new,—and two of *Scnipæus*, probably both new. They reject Koch's genera *Linotænia* and *Stenotænia*, because the principal mark of distinction between them, the varying thickness of the anal legs, is in most species a sexual distinction; and they consider the species of *Stenotænia* to be the females of corresponding males described as species of *Linotænia*. They also reject both names, as being formed in direct violation of the rules of nomenclature, and in any case only applicable to congeners of *Tænia*. The species in question are united in the new genus *Scolioplanes*, of which they enumerate three species as Danish. They propose a new genus, *Schendyla*, based on Koch's *Linotænia nemorensis*, and distinguished from *Scolioplanes* by the labrum being united to the clypeus, the cutting-edge of the mandibles short, with but few teeth; the maxillæ of the second pair are small, but the claw of the first pair of maxillary legs is exceedingly large, and the anal legs, even in the female, very thick. *Himantarium subterraneum*, K., is also mentioned as Danish.

Dr. Bergsøe's paper on the *Tarantula* (iii. p. 239) and the curious phenomena of Tarantism contains a careful and interesting examination of the voluminous literature of the subject, proving that the term "tarantism" has been applied to facts of entirely different nature, which, thanks to popular superstition and ignorance, have been confounded with and all ascribed to the poisonous wounds

inflicted by certain animals, though in reality only a small minority can be so explained. He points out a strong analogy between mediæval tarantism and the dancing manias which have visited several parts of Europe at different periods; and he considers it very probable that a similar epidemic developed itself independently in Italy, and that only superstition ascribed it to the various kinds of "tarantola." But Dr. Bergsøe does not think that this explanation exhausts the question. He is of opinion that a very large part of these phenomena are to be ascribed to a kind of local fever generated by the highly unhealthy exhalations from the soil of Apulia, and that the subjects of this kind of tarantism (which still occurs not unfrequently in Apulia) were simply the victims of malaria. This view of the matter explains why tarantism was so rare out of Apulia, although tarantulas occur in most parts of Italy,—a circumstance which has not failed to puzzle the ancient writers on the subject, and led them into various unreasonable hypotheses—for instance, that the animals lost their venomous properties by removal from their native soil. Finally, the undoubted poisonous properties of the wounds inflicted by some of the various (sometimes, however, quite harmless) animals comprised under the popular name of "tarantula" (particularly by the well-known spider of that name, by scorpions, probably also by *Scolopendras*), may account for some of the lighter cases of tarantism; but it is only want of hygienic knowledge combined with the instinctive dread, common with uneducated people, of small, strangely shaped, creeping animals, which has caused so many different phenomena of disease to be ascribed to their agency. Dr. Bergsøe gives an interesting account of the habits of life of the true Tarantula, which certainly does not favour the idea of its coming easily in contact with men; and he mentions several hitherto overlooked peculiarities of structure, of which we note the existence of special provisions for facilitating the carrying of the young on the back of their mother. Not only are the claws and their five teeth in the young proportionally very long and sharp, but the hairs forming the felt-like covering on the back of the female Tarantula are specially constructed for the purpose, consisting as they do of a basal bulb, a short smooth stem, surmounted by a much longer part covered with stiff spinules or bristles pointing upwards, and terminating in a very minute rounded head or button. The hairs on the legs present a similar structure, but are much softer and without the terminal button; but the long stiff hairs interspersed with the felt on the back are quite plain; nor is this complicated structure observed in the hairy covering of the male.

Philichthys Xiphias, Steenstr., was first discovered by the late Prof. Eschricht on the head of a *Xiphias gladius*, L., and briefly described by Prof. Steenstrup, who also drew attention to the probability of its frequent occurrence as a parasite of that fish, in certain cavities connected with the muciparous canals on the head. He was, however, unable to assign it a place in the zoological system, on account of its extraordinarily deformed appearance, which led him to suggest that it might belong to the class of Annelida. This

hypothesis, however, he abandoned, another specimen of *Xiphias gladius* having been taken in the Sound in the autumn of the following year, on the head of which the same parasite was observed, in a similar cavity, but accompanied by a small Entomostrakon. Assuming this to be either the male or the young of the larger parasite, Prof. Steenstrup inferred from that circumstance that the latter was a Crustacean; but he did not enter into any further description. Meanwhile Dr. Bergsøe had availed himself of a stay on the shores of the Mediterranean for an investigation of the history of this remarkable animal; and the results are embodied in the paper above mentioned (iii. p. 87), to which is added a Latin *résumé* for those who do not understand Danish. The details of the structure are apparent from the very full description and the plate; and from these the author concludes that the proper place of the animal is amongst the Copepoda nearest Ergasilini, though at the same time he expresses the expectation that, when other similar parasites have been discovered, they will be found to constitute a new family. He gives besides a very minute account of the cavities in which the animal is found. It appears that the female fixes itself in a convenient place in the muciparous canals on the head; and by degrees, as the animal grows, the cavity grows with it. Where the canal is close to the surface of the skull, large cavities are formed in the bones; and in these cases the skin covering them and protecting the parasite is thin and perforated. But where the cavities containing the *Philichthys* are developed in parts of the muciparous canals not in contact with the bones, they are generally smaller, and the integuments thick and without perforations. The cavities rarely contain more than one female attended by a male. In any case the cavities are easily observable from without; and the fishermen of Messina are well aware of the parasite, which they call "Pulce." Dr. Bergsøe recommends the examination of other large fishes of the Mediterranean, such as the different species of *Thynnus*, *Histiophorus*, *Tetrapturus*, *Belone*, as he expects that similar parasites will be found in them. The *Philichthys* affords one of the very few instances of a parasitic Crustacean living entirely inside the body of its host, though its choice of abode, considering how much communication there is between the muciparous canal and the outside, is not without analogy with the habits of those numerous parasitic crustaceans met with in the branchial cavities of fishes.

Dr. Bergh, who for many years past has occupied himself with the study, and more particularly the anatomy, of Mollusca, and published several valuable papers on the subject, has contributed to the fourth volume of the 'Naturhistorisk Tidsskrift' (pp. 1 & 207) a monograph of the family of Pleurophyllididae, embracing the substance of some smaller papers previously published, but containing a far greater quantity of new matter. The number of species described is seventeen, of which six are established by Dr. Bergh, belonging to the genera *Pleurophyllidium*, Meckel, *Sancara*, Bergh, and *Camarga*, Bergh. Having been favoured with specimens for dissection, both from private collections and from the museums of

Copenhagen, Berlin, and Stuttgart, he has been enabled to present an exceedingly full account of the anatomy of these hitherto little-known animals, in which very many new facts will be found, but which space forbids us to extract. The diagnoses are all in Latin, as well as the explanation of the plates (nine in number), containing anatomical details.

M. Ström's papers on Danish Lepidoptera (iii. pp. 1 & 107; iv. p. 381) contain several observations of more than merely faunistic interest, of which we can only find room for one. He points out a gradual degradation, as it were, in the females of *Orgyia antiqua*, *gonostigma*, and *Ericæ*, corresponding to peculiarities in their development, the antennæ being dentated in the first, crenulated in the second, but much shorter and merely filiform in the third; the rudimentary wings are closely covered with hair in the first, sparsely haired in the second, exceedingly small and naked in the third; and the legs show a similar gradation. Accordingly he has found that the female of *O. antiqua* entirely disengages herself from the double cocoon, and places her eggs on the outside of it; whilst that of *O. gonostigma* only perforates the inner cocoon, and remains hidden behind the outer cocoon, which forms a sort of curtain, leaving a sufficiently large opening to admit the male; and the female of *O. Ericæ*, finally, never leaves the pupa-skin, just as is the case with some species of *Psyche*. Probably, in order to facilitate the fecundation, the pupa is placed in an inverted position in the cocoon, which is found in the tops of the heath.

The Record of Zoological Literature, 1866. Volume III. Edited by ALBERT C. L. G. GÜNTHER, M.A., M.D., Ph.D., F.R.S. &c. Van Voorst, 1867.

In consequence of the illness of one of the Recorders, the volume of 'The Zoological Record' for the literature of 1866 was published at a later period than usual. "An undertaking of this kind," it is observed in the preface, "must, of necessity, be occasionally exposed to the danger of such a delay without the Editor having it in his power to guard against it."

Each year that this work comes to us we feel more and more its extreme usefulness. Without some such help as that afforded by this volume it is impossible for the zoological student to keep up with the literature of the day. The number of investigators in every branch of natural history is year by year increasing: the works published, in all languages, multiply in like proportion; many of them are extremely difficult to procure through a bookseller, and not to be found in our best public libraries; and periodicals devoted to natural history in general or to some particular class, and Transactions and Proceedings recording the investigations of the members of the rapidly increasing number of scientific societies, render the attempt of the individual worker to keep himself acquainted with all that is being written almost hopeless. Here, then, the 'Zoological Record' comes

to his aid; in it he finds the pith and marrow of all that has been published during any year:—the new genera described; references to the descriptions of the new species of any particular genus; summaries of the more important points in papers which treat of geographical distribution, of classification, of anatomy, physiology, &c. The third volume of the 'Record' forms a systematic guidebook to about 80,000 pages of the zoological literature published (with the exception of a comparatively small part) within the year 1866. This number, we further learn from the preface, is divided between the various classes thus:—Mammals 3000, Birds 4500, Reptiles 1000, Fishes 2400, Mollusks and Molluscoids 2000, Crustaceans 900, Arachnids and Myriopods 1000, Insects 11,000 (viz. Coleoptera 5000, Hymenoptera 1300, Lepidoptera 2100, Diptera 730, Neuroptera and Orthoptera 430, Rhynchota 900), Annelids 1000, Scoleicides 900, Echinoderms 170, Coelenterates 860, Protozoa 900. We believe that in saying we feel we owe a great debt of gratitude to Dr. Günther and his able coadjutors for the valuable assistance they give us in the yearly summaries of the 'Zoological Record,' we are giving expression not to our individual feelings, but to those of students in zoology generally. That gratitude is enhanced by the fact that we are aware that the work has as yet been published not only at the cost of much time and labour, but also at the sacrifice of pecuniary loss to Dr. Günther, his fellow labourers, and that most enterprising publisher, to whom naturalists owe so much, Mr. Van Voorst. We trust that a yearly increasing sale, as the 'Record' becomes more widely known on the Continent, may by degrees turn that loss into a profit. Meanwhile, at the Meeting of the British Association at Dundee, steps were most justly taken to secure the editor from further loss in the publication of the volume for the ensuing year. We shall rejoice if at future meetings of the Association similar aid is volunteered on the part of the Committee. Most certainly there is no purpose to which a grant in Section D can be more advantageously applied than in the preparation of a publication of the value of which every scientific zoologist is fully sensible, and the discontinuance of which would prove a great drawback to the "advancement of science."

Volume III. unquestionably surpasses either of its predecessors in the carefulness and completeness of its execution. The Records remain the same as in the former volume; but they have learned by experience, and, warming to their work, do it more effectually. Perfection in the first volumes of such an arduous undertaking it would have been most unreasonable to look for; but they came nearer to perfection than could have been expected. Improvement is, however, obvious in the 'Record' of 1866, especially, where it was most needed, in the reports on the lower classes of animals. In the first volume there was no notice on the Coelenterata and Protozoa; in the second volume the literature of 1864 and 1865 was epitomized, but the analysis was not as satisfactory as could have been wished. In the present volume, however, we find this part of the subject well handled.

Mr. Sponce Bate, in his references to Mr. Norman's "Report of

the Committee appointed for the purpose of Exploring the Coasts of the *Hebrides* by means of the Dredge," in almost every instance gives the habitat of the new genera and species described as "*Shetland Isles!*" a *lapsus* certainly calculated seriously to mislead those who do not refer to the original paper. We notice also, in this report on the Crustacea, constant references in cases where, on turning to the original (*e. g.* to the papers of Goës, Heller, Sars, &c.), we find no information beyond that given by the Recorder, viz. the name and locality. Such references to the commonest of species, as "*Cancer pagurus* (L.), Sars, *l. c.* p. 10," or "*Pagurus bernhardus* (L.), Sars, *l. c.*; Sp. B., Brit. Assoc. Rep. 1865, p. 52, and Ann. Nat. Hist. vol. xvii. p. 25," are worse than useless, when, on turning to the original papers, we find nothing but the name. In dealing with catalogues it is surely the better plan to give a short abstract of results in a note following the title of the paper, mentioning the total number of species recorded, and adding the names of such as seem peculiarly interesting from the fact of our knowledge of their geographical range being thus materially extended, or other circumstances. In one case, "*Corophium bonelli* (Edw.), Heller, *l. c.* p. 51," we cannot find even the name; the species is not mentioned by Heller either on that page or in any other part of his work.

PROCEEDINGS OF LEARNED SOCIETIES.

DUBLIN NATURAL-HISTORY SOCIETY. *

The monthly meeting of this Society was held at the Royal Irish Academy, on Thursday the 5th of February, the Rev. Prof. O'Mahony, A.M., in the Chair.

Mr. Bradshaw read a paper "On the Habits of some Irish Birds."

Dr. Macalister read a paper "On the Myology of the Otter (*Lutra vulgaris*)."

Mr. W. Andrews, M.R.I.A., Chairman of the Natural-History Committee of the Royal Dublin Society, stated that he was anxious to have placed on record several species of rare Irish Sponges that had been noticed at the early meetings of the Society, but which had not been mentioned as Irish in Dr. Bowerbank's recent work on British Spongiadae. Very fine specimens of *Grantia nivea* of Johnston (*Leuconia nivea*, Bowerbank) were exhibited by Dr. Scouler, in May 1844, obtained from Roundstone Bay, Connemara. The singularity of the species from that coast does not appear to have been noticed by Bowerbank, who gives no record of any Irish locality; by Thompson the name is merely given, "west coast of Ireland, M'Calla." Dr. Scouler, at a meeting early in 1846, gave the characteristics of *Halichondria hispida*. This rare species had not been obtained since it was recorded by Montagu, in the Wernerian Transactions, as met with on the south coast of England,—this discovery being its first record as Irish, it not having been until then found since the time of

Montagu; it is mentioned in Bowerbank as *Dictyocylindrus hispidus*, but no Irish locality given. At the same meeting Dr. Scouler brought to notice fine specimens of *Halichondria Johnstonia*. Dr. Scouler considered at the time that it presented features so different from what had hitherto been recorded, from its remarkable papillous appearance, and in the peculiarity of the pores, as to form it into a new genus—*Amphitrema*. It has not been recorded from the coasts of Ireland by either Johnston or Thompson. It has been collected in several parts of Galway Bay; but Mr. Andrews was not aware of any other locality on the Irish coast. Dr. Bowerbank has formed it into a new genus, *Pachymatisma* (*Pachymatisma Johnstonia*). A drawing was made by the late Dr. Harvey, and several characteristics of the spicula noticed, which present great variety of forms, similar to several occurring in other genera. The ovaria are numerous imbedded in the structure.

One of the most remarkable that had been collected in Galway and Dingle Bays was *Halichondria celata*, Johnston (*Cliona celata*, Grant, and subsequently named *Raphirus Griffithsii* by Bowerbank). No sponge has caused more confusion than this, whether we consider its range in deep and shallow water, its varied distribution of attachment, or the very dissimilar outline of form and structure it not unfrequently assumes—so much so, that *H. celata* of Johnston had been divided into twelve species. It still presents such anomalies that it is not improbable that new features may be described when the question of its decided animality is more thoroughly investigated. It is one of those difficulties that have to be encountered in the examination of the anatomy and physiology of the sponges; for unless collected and dissected with care in the living state, no true characteristics can be depended upon. Dried specimens give by no means even a correct outline of their form or mode of growth; and the more remarkable features are altogether lost—the peculiar action of the oscula and pores, the mode of reproduction,—independent of the beauty of their tints, which are altogether altered in the dried state or in spirit preparations. Mr. Andrews frequently noticed the great alteration of character that almost suddenly takes place in marine objects, especially delicate species, when placed in spirits. Mr. Andrews regretted to find, on inquiry, that the collection of sponges that had been made for the Natural-History Society had been put astray or lost at the time of the confused removal of the museum from the rooms which the Society held in Brunswick Street, and also that not more than one-third of the specimens are at present forthcoming in the Royal Dublin Society's collection, formed by Dr. Scouler—which may be attributed to the same cause, the packing and stowing away when the change from the rooms and the alterations in the museum were made. There were several unique specimens that had been collected by M'Calla.

MISCELLANEOUS.

On the Gingee Squirrel of Sonnerat.

SONNERAT, in his 'Voyage' (vol. ii. p. 140), very shortly describes a Squirrel, under the name of *l'Ecureuil de Gingi*, thus:—

"Rather larger than *Sciurus vulgaris*; fur entirely earthy grey, paler on the belly, legs, and feet; on each side of the belly is a white streak extending from the armpits to the thighs; eyes surrounded with white; tail entirely black, with some white hairs." The following names have been given to the subject of this notice:—

Sciurus dschinschicus, Gmelin, S. N. i. p. 151.

S. gingianus, Shaw, Zool. ii. p. 147; Kuhl, Beitr. 67.

S. albovittatus, Desm. Mam. 358; Horsf. Zool. Java.

S. albovittatus, var. *dschinschicus*, Fischer, Syn.

Macroxus albovittatus, Lesson.

Gingee is in the Carnatic, near Pondicherry. Sonnerat's description has been considered to indicate a variety of *Xerus setosus* of Africa, which has spiny fur; but in that animal the streak is on each side of the back, and not on the sides of the belly. There is not a word in the short description to lead one to believe it was a spiny Squirrel, or lived on the ground; and I have never seen a *Xerus* from India. Sonnerat's animal either belongs to a species not in European museums and not noticed by recent Indian naturalists, probably allied to *S. platani* of Java, or it may be a variety of the *Macroxus bicolor*, which is found in various parts of India and the Malay peninsula. It would be very interesting to receive a specimen, agreeing with Sonnerat's description, from the Carnatic.—J. E. GRAY.

On the Mode in which certain Rotatoria introduce Food into their Mouths. By E. CLAPARÈDE.

In the *Zygotrocha* of Ehrenberg the vibratile apparatus may be regarded as double. The movement of the cilia is always in the same direction and opposite to that of the hands of a watch; hence it is directed towards the mouth in the right wheel and from it in the left one. But observation proves that food passes to the mouth both from right and left, which is incompatible with the received notion that the currents conveying the food are produced by the vibratile apparatus. The examination of such Rotatoria as the *Melicertes* and *Lacinularia* leads to the same result.

In *Melicerta ringens*, on the lower surface of the membranous vibratile organ and parallel to its margin, M. Claparède finds a sort of crest, between which and the margin there is a deep furrow. The extreme margin bears the well-known large cilia: the crest also

bears cilia ; but these are long and delicate, and their movement is opposite in the two halves of the apparatus. By their means foreign bodies which get into the channel between the two ciliated crests are pushed gently along and conveyed to the mouth, being retained in their position by the inferior range of cilia.

The action of the whole apparatus is explained as follows by M. Claparède :—The superior range of cilia when in action produces currents tangential to the vibratile organ and perpendicular to its plane. These currents are closed and appear to be nearly of an elliptical form ; particles involved in them pass repeatedly over the same course, and if they are thus brought in contact with the extremities of the inferior cilia, which reach a little above the base of the superior range, they pass into the channel above mentioned and are pushed along in it towards the mouth. The author remarks that the apparent movement of the inferior cilia is from the mouth ; but this is illusory and due to the circumstance that the slow elevation of each cilium preparatory to its stroke produces a greater effect upon the eye than the more rapid stroke itself. This double row of cilia in *Meliceria* and *Lacinularia* has been observed and described in this country by Huxley and Williamson, and in Germany by Leydig ; but its existence seems to have escaped the notice of subsequent observers.

Professor Huxley has also observed this second row of cilia in *Philodina*, a genus belonging to the Rotatoria Zygotrocha. M. Claparède here describes and figures it in *Rotifer inflatus* (Duj.), in which the inferior cilia are borne upon a crest which is oblique relatively to the plane of the vibratile wheel ; in all other respects the arrangement and action of these inferior cilia are the same as in *Meliceria*. The same characters have been observed in *Rotifer vulgaris* (Ehr.).

M. Claparède appends to this paper a note confirming Mr. Gosse's account of the mode in which *Meliceria ringens* builds up its tube, and remarks that this does not appear to have attracted attention on the continent.—*Annales des Sciences Naturelles*, série 5, tome viii. pp. 5-12.

Habits of Volutes. By Dr. J. E. GRAY, F.R.S. &c.

Volutes are rarely collected with their animals, except when they are accidentally thrown ashore after a storm. They have therefore been said to be animals which lived in the depths of the sea. The reason they are not found is that, like the *Natica*, they bury themselves in the sand as soon as the water falls and the sand is left dry by the tide ; they are only to be procured by digging for them, or when the storm has been sufficient to disturb the sand and throw them on the beach. Mr. Cutter informs me that he has walked for miles along a sandy beach in Australia without finding a specimen ; but on talking to a fisherman about the shells, he told him the sand abounded with them ; and taking him back to the sand which he had traversed, on digging up a spot on the sands which was drier

than the rest, as if some one had trodden on it, the Volute was found; and in this way many were obtained in a living and beautiful state.

On Loxosoma Kefersteinii, a soft Bryozoan of the Bay of Naples.

By E. CLAPARÈDE.

In 1862 M. Claparède discovered on the coast of Normandy an epizoon of the worms of the genus *Notomastus*, which was shortly afterwards described by Professor Keferstein under the name of *Loxosoma singulare*. It is a Bryozoon, allied to *Pedicellina* (Sars), in which the anal extremity of the intestine pierces the wall of the pharynx, and opens outwards in the middle of the mouth. It is entirely soft, being destitute of the hard integuments so general among the Bryozoa.

The bay of Naples contains a great abundance of a second species of *Loxosoma*, measuring about half a millimetre in length (exclusive of the peduncle); it lives, attached by its peduncle, upon various animals, chiefly Bryozoa of the genus *Acamurchis*. M. Claparède names it *L. Kefersteinii*.

The body is of an elongate-ovoid form, obliquely truncated in front by the buccal funnel, into which the ciliated tentacles are usually retracted under the abnormal conditions induced by observation. The funnel contracts so as to form a sort of diaphragm above the mouth and anus; but this always presents an aperture by which the water may penetrate freely into the cavity of the funnel, where it is constantly renewed by the movement of the cilia covering the inner surface of the wall of this cavity and the inner surface of the tentacles.

The tentacles appear to be fourteen in number; *L. singulare* has only ten. The digestive apparatus is arranged as in the species from the Channel; the lower extremity of the buccal funnel passes gradually into the œsophagus, which extends to the posterior extremity of the body, where it bends round and opens into a large greenish-yellow stomach. From this springs a short, cylindrical intestine, which pierces the wall of the pharynx to open externally in the middle of the mouth. The anal portion does not rise, as in *L. singulare*, like a kind of chimney, to the highest region of the buccal funnel.

The author thinks that this interpretation of the parts of the alimentary tube is not quite free from doubt, and that it is possible the part called by M. Keferstein and himself the mouth may be the anus, and *vice versa*.

The very contractile peduncle is of variable length, but always much longer than in *L. singulare*. It terminates in a sort of sucking-disk; and six or seven bands of muscles run from one end of it to the other; these are separated from each other by the same number of rows of nuclei, 0.006 millim. in diameter.

The only individuals showing sexual organs were females, and in these the ovaries exactly resemble those of *L. singulare*. Most of the specimens were engaged in gemmiparous reproduction, the buds

being formed only at two points, one on the right, the other on the left of the posterior third of the body. This is also the case in *L. singulare*. The number of buds may reach five or six on each side; on attaining a certain size they detach themselves, and then adhere to the *Acamarchis* close to their parent.—*Annales des Sciences Naturelles*, série 5, tome viii. pp. 28–30.

New British Fishes.

Mr. William Edwards, of St. Mary-at-Hill, E.C., being at Hull when the fishing-smack 'Swallow,' of Hull, Capt. Thomas Sparks, arrived, which had been five weeks on a fishing voyage, having been blown over the north side of the Jutland Reef, observed that she had brought with her some specimens of *Chimæra monstrosa*, of *Sebastes viviparus*, and of the Black Centrina (*Spinax niger*). Mr. Edwards kindly sent and presented two specimens of *Chimæra* (male and female) and one of each of the other specimens to the British Museum. It is the first time that *Sebastes vivipara* and *Spinax niger* have been caught so near the English coast. They are interesting additions to the marine fauna.—J. E. GRAY.

Cetacean Animals in Museums.

Prof. Van Beneden has lately published a catalogue of the skeletons of Cetacea contained in different museums. According to his Catalogue, the British Museum contains the skeletons or parts of skeletons of sixty-one species of Cetacea, the Paris Museum thirty-four species, the Museum of Louvain (under M. Van Beneden's own direction) twenty-five species, the Museum of the College of Surgeons twenty-one species, the Museum of Leyden twenty-one species, and the Museum of Brussels nineteen species. These are the museums mentioned that have the largest number of species. The British Museum also contains twenty stuffed specimens of Cetaceans, belonging to eleven species, three of the specimens being whales, the rest dolphins and porpoises.

THE LATE PROFESSOR VAN DER HOEVEN.

Jan Van der Hoeven, the Professor of Zoology in the University of Leyden, who was born in Rotterdam on the 9th of March 1801, died at Leyden on the 11th of March 1868. He was the author of various papers on different branches of zoology. A list of no less than seventy-eight essays occurs under his name in Engelmann's 'Bibliotheca Zoologica.' He published a very good 'Handbook of Zoology,' which was translated for English students by Prof. Clark, of Cambridge.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 5. MAY 1868.

XXXIX.—*Contributions toward the formation of a correct System of Muscular Homologies.* By ALEXANDER MACALISTER, M.D., L.R.C.S., L.K.Q.C.P., Demonstrator of Anatomy, Royal College of Surgeons, Ireland, one of the Honorary Secretaries of the Royal Geological Society of Ireland *.

THE literature of comparative anatomy is teeming with memoirs and essays on that department of homology which treats of the serial comparison of the muscles of the fore and hind extremities in vertebrate animals.

Almost every writer has originated an hypothesis of his own (some of these being plausible and some fanciful), starting from which he proceeds to work out details, some of which in all theories are undoubtedly true; but every author has differed from his predecessors and successors in his reading of these serial homologies. In the majority of these theories muscular peculiarities have been regarded as subsidiary to osseous arrangements, and many authors have deduced their ideas of homotypical myology from the study of bones rather than from the direct consideration of the muscles themselves and of their relative positions, courses, and attachments. Such being the present position of this branch of comparative anatomy, no apology is needed for bringing forward any observations which may perhaps have the advantage of novelty, and which may elucidate in some degree the vexed question of serial homologies. A great number of the misapprehensions into which anatomists have fallen with respect to these homologies are due to the fact that the individual components of the fore limb of a limited number of animals have been compared directly with those of the hind extremity, irrespective of the differences of the work to which they may be devoted; but this is a mistake in principle, and one from which we may free ourselves by

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regarding the two limbs not immediately as being representatives the one of the other, but as different expressions of a certain type limb, to some extent ideal because not found as an unmodified entity in any animal, but upon whose basis every vertebrate limb is constructed; and apprehending this, we should compare the individual limb before us with the corresponding part of the type extremity,—just as in the science of botany we learn that the various parts of the flower (sepal, petal, stamen, and carpel) are modifications, not of the leaf as Goethe taught, but of a certain ideal organism or phyton, of which the leaf itself is only a variety.

As the study of comparative osteology leads us to the conclusion that there is a typical skeleton, of which all vertebrate skeletons are modifications, so the study of myology teaches us that there is a typical vertebrate *myozoon**, of which the individual vertebrate muscular systems are modifications.

Adopting the theory of a myozoon, the main point of our inquiry resolves itself into a determination of the nature and components of the typical limb; and in our researches we shall commence with such portions as present us with the most clear and constant uniformities of arrangement, and consequently with the fewest difficulties. Thus we will, in the first place, endeavour to resolve into their typical positions the muscles of the terminal segment of the vertebrate limb—the pes or the manus.

There is no primary difficulty in deciding the landmarks in this segment: the pollex and hallux, the little toe and little finger, the carpus and tarsus are undoubtedly correspondent; and the latter may be arranged as follows into a tabular series whose resemblances are evident:—

Scaphoid	= os naviculare pedis.
Semilunar	= astragalus (body).
Cuneiform	= calcaneum.
Pisiform	= sesamoid bone in the long peroneal tendon.
Trapezium	= entocuneiform.
Trapezoid	= mesocuneiform.
Os magnum	
(body)	= ectocuneiform.
(head)	= astragalus (head).
Unciform	= cuboid.

Of the five digits typically present there are two which ge-

* I should, perhaps, apologize for attempting to intrude a new name upon an already name-encumbered science; but I think any new word may be admitted whose meaning is easily understood, when it saves us the trouble of circumlocution. *Myozoon* = *μῦς ζῶον*, muscle animal.

nerally exhibit an individuality of action separate from the others: these are the inner and the outer. For these we have what at first sight appear as separate special muscles often present; but, as Meckel remarked, these can be resolved into the ordinary and typical series which we have developed for the others, only in a position of greater specialization.

Discarding for the present the longer digital muscles, we can resolve the muscles of the pes and manus into the following:—

1. A short extensor for the fingers or toes.
2. A short flexor for the fingers or toes.
3. A complete series of palmar interossei.
4. A complete series of dorsal interossei.

The first of these muscles is developed on the dorsum of the human foot, and is there attached to the four inner toes; only, however, in the case of the great toe is its typical insertion into the first phalanx preserved, as in the three other digits its tendon is confluent with that of the long extensor. It is not usually inserted into the little toe; but I have once seen this muscle in man sending a fifth tendon to that organ. In the manus of man a corresponding muscle occurs as an anomaly occasionally, and as such has been described by Mr. Wood (Proc. Royal Soc. 1865, p. 382) and by myself (Proc. Royal Irish Acad. April 1867); when present, it is often inserted, fleshy or tendinous, not directly into the fingers, but into the extensor longus tendons. This muscle is of rare occurrence in the normal anatomy of lower animals; to my knowledge it is only described as present in the *Bradypus tridactyla*, according to Meckel; and the same writer describes a corresponding muscle arising from the lower end of the ulna in the two-toed Anteater. The comparative anatomy of this muscle in the pes exhibits but little variety; it is present in *Ornithorhynchus*, *Hyrax*, *Myrmecophaga*, *Macropus*, *Arctomys*, Bear, *Nasua*, *Pteropus*, *Rhinolophus*, *Stenops*, *Macacus*, *Ateles*, *Cebus*, *Callithrix*, *Cercopithecus*, Ai, *Hystrix*, and many other animals, in different degrees of perfection, but never varying to any great extent from its usual place.

The second of these muscles may be looked upon as the antithesis of the short extensor: it is the short flexor of the toes and fingers. If we compare the actions of flexion and extension of the digits, we shall find at once that, usually, the latter is provided for by the great development of large and long muscles arising in the forearm. On account of this the flexor of the first phalanx is not usually needed in this its primary capacity; and consequently we find it split up or mo-

dified in several singular ways. As we saw that its antithesis, the extensor, was sometimes inserted, not into the bones directly, but into the common extensor tendon, so we usually see, as in the human pes, part of this flexor arising from the first row of the tarsus, and inserted, as the musculus accessorius, into the tendon of the flexor digitorum longus. And as, from the hyperdevelopment of the calcaneum, the latter tendon is forced to run obliquely to its insertion in the human and some other pedes, so this muscle is adapted in such cases to fulfil the special function of obviating what would otherwise be the faulty direction of the long tendon, and altering its line of action into one of greater convenience: for this purpose the muscle is shortened, or at least its belly is tacked on to the flexor tendons near to the ankle. But the muscle does not terminate here; for, separated from the typical origin by the tendons to which the latter has contracted an adhesion, the continued slips of insertion sink into the interspaces of the tendons, and thence are inserted into the fingers under the name of lumbricales. Within the present session I have seen several distinct examples of the continuity which sometimes subsists in the human foot between the lumbricales and the massa carnea accessoria. In other animals we find the musculus accessorius, varied to a slight extent in direction: it is present in *Ateles*, *Cebus*, and other monkeys. This massa carnea Sylvii, however, is not all of this short flexor; there is one slip which usually preserves its natural connexions—the superficial head of the flexor brevis pollicis manus. It is a typical portion of the muscle, arising from the carpus and inserted into the first phalanx of the pollex through the intervention of the outer sesamoid bone; and this leads us to the consideration of this muscle as developed in the manus. In *Hyrax capensis*, according to Drs. Mivart and Murie (Proc. Zool. Soc. 1865, p. 341), the muscle is present as a flexor brevis digitorum manus, sending slips to the second, fourth, and fifth digits, the slips arising by a large muscular belly in the vicinity of the palmar cartilage; in this case the muscle is developed typically. It may seem as an *à priori* difficulty that this animal has two lumbricales (although Meckel denies their existence) as well as the large typical flexor; but this in reality can easily be understood, as the former are but deeper and differentiated slips of the muscle, just as in the antagonistic foot-muscle, the extensor brevis, I found on a recent occasion two tendons, distributed one to the outer and the other to the inner side of the second toe, all the others being regular. The lumbricales described by the above authors in *Hyrax* are distributed to the second and fourth toes in the fore limb, but to the second and

third in the left foot; of these the second, as indicated in the foot, is evidently the missing third-toe muscle, while the first may be the first-toe muscle, which is not otherwise developed. If this be the case, the matter is still more clearly explicable in accordance with the type proposed above. In *Dasyprocta* the same authors speak of a palmaris brevis muscle attached to the palmar ossicle, but not connected with the digits, arising from the first and fifth metacarpal bones. This muscle is a backward prolongation of the type muscle, and evidently represents the accessorius of the foot; it is not present in the hare or rabbit, but in the guineapig it is distinctly traceable. A small muscle invests the flexor tendons still further forward in *Agouti*, similar to the flexor brevis manus, but which has no separate digital insertion; from the tendons themselves spring the lumbricales, three in number, as in the cavy, guineapig, rabbit, and hare: thus these three severed portions, if united, would constitute an accurate and typical flexor muscle of this series. In the human hand we find that this muscle, losing its bony origin, is connected to the palmar fascia on the inner side, and is known by the name of palmaris brevis, while its digital slips remain as the lumbricales. I have seen this muscle springing from the pisiform bone. Having thus traced this flexor series through its various mutations, we see that, despite its variability of form, it presents a constancy in its presence, and is sometimes developed in a high degree of complexity—for instance, in *Nycticebus* and the Lemuridae in general, according to the illustrations of Messrs. Mivart and Murie, and the text of Meckel, Vrolik, and others. We find in these animals:—first, a double set of ordinary lumbricales, one on each side of each finger; secondly, an accessory set, likewise in duplicate; and, lastly, a third series, passing from the second to the third phalange of each digit: there are thus, as Meckel states, twenty-four muscles in all of this lumbrical group; of these the first and second groups are only highly differentiated slips of the flexor brevis manus, while the last set may be continuations of the true dorsal interossei.

The next groups of muscles in this segment are the interossei, palmar and dorsal, devoted to the purpose of lateralizing the digits, the first series being flexors, and the second being extensors. In the typical limb, where each digit has a vital individuality of action, we should expect to find these muscles characteristically and perfectly developed; but as in the limbs of most vertebrates, when possessing four or five digits, only one or at most two of them maintain this separateness of action, in the intermediate segments consolidation of the metacarpals or metatarsals interferes with independency of action; still we find

the uniformity of development of the typical muscle-germs distinctly traceable. It must at once be noticed that the interossei of the human hand and human foot do not correspond, but differ strikingly in respect to their line of action—those of the manus working to and from the line of the middle finger, those of the pes having a similar relation to the second toe. In the pes of the chimpanzee, Humphry has found them arranged in the same way as we find in the human manus. In the gorilla, Duvernoy and Halford found them to be arranged in the same manner; and the latter anatomist has met with the same arrangement in *Macacus*. I have examined them in *Cercopithecus*, *Macacus*, *Rhesus*, and *Cynocephalus*; and Mivart has examined the first-named genus, and found them alike. Prof. Humphry has dissected them in the dog, and has found the same arrangement, which I have likewise confirmed, in a dingo. In the manus of *Dasypus* I have found them arranged thus:—the fifth digit had an internal interosseus from the carpus to the first phalanx; the fourth had none; the third had a fasciculus attached to its ulnar side; the second had a special one to its radial side; and the pollex had one to each side. Thus we see another instance of a variation from the true manus type. But it is in *Ornithorhynchus*, *Hyrax*, and *Nycticebus* that these attain their greatest degree of complexity. In the first named a regular double set of muscles occupy the interosseous spaces, one for each side of each finger. In *Hyrax* there are two sets of interosseals:—first, a regular set, one at each side of each finger, and inserted into the sesamoid bones at the base of the first phalanges; secondly, a group of longer muscles—one an external muscle for the index, two external parallel muscles for the annularis, and one for the little finger, supplemented by an abductor minimi digiti. In the foot of this animal there are internal and external muscles for the index, middle, and fourth toes, an external muscle for the third, and of the longer series an inner tendon for the third, and external muscles for the second and first. The *Nycticebus* likewise possesses a complex group of interossei as well as of lumbricales, as in its manus are found an abductor and flexor brevis pollicis, external and internal interossei for the index, middle, annular, and little digits, supplemented by a special abductor of the latter and by a transversus pedis consisting of two slips, one springing from the second and the other from the third metacarpal bone. The rat and hare possess four pairs, as also does the rabbit; while the guineapig and *Agouti* exhibit three pairs of interossei.

In deducing from these apparently dissimilar series a regular typical form we see that the entire difficulty may be set at rest

by the assumption that for the typical digit there are four such muscles—a palmar on each side and a dorsal on each side. In the human manus, which we will take for illustration as the most familiar, we have these developed as follows. The pollex on its free side has a muscle, the abductor, which, however, is generally divisible into two, an abductor exterior and interior, so named by Sömmerring. The interior of these, undoubtedly, acts (as Meckel suggests) as a palmar interosseus; this muscle is present in *Ornithorhynchus*, in the opossum, in the bear, *Gulo*, and others. On its ulnar side a muscle is occasionally present as an anomaly in man, described by Henle—the interosseus primus volaris, which I have never found as a portion of the normal anatomy of any animal. Meckel, however, in speaking of the short muscles of the thumb, says:—“Il y a quelquefois, par exemple chez le magot, un petit fléchisseur plus profond que l'on rencontre parfois aussi dans l'homme.” This might perhaps be the muscle of Henle; and Prof. Huxley has described it as existing in the gorilla (*Med. Times & Gazette*, 1864, p. 538). For the index finger there is a radial palmar muscle, which in the human subject arises from the os magnum and the base of the third metacarpal; but as its function as a radial lateralizer of the index is better fulfilled by one of the dorsal muscles, its insertion is shifted to the inner sesamoid bone of the pollex, and it becomes the deep head of the flexor pollicis. I have found this muscle in *Hystrix cristata*; and, as stated above, in *Dasypus* this muscle is present and typical, attached to the radial side of the index. The palmar ulnar interosseus is developed as the first palmar interosseus of the human hand. It is present in the pes of many monkeys, of the dog, and the *Ornithorhynchus*. For the middle finger the two palmar interossei, being superseded in function by the dorsals, would be entirely atrophied, but that they are devoted to a special purpose; and hence, coalescing, they are inserted into the inner sesamoid bone of the pollex, constituting the adductor pollicis. In the dog this muscle is represented by a fibrous band, not truly muscular; it is muscular, however, in *Ursus arctos*; and in some monkeys (as *Macacus nemestrinus*) it is large; in *Ursus* a slip of it is occasionally inserted into the second toe at its base, constituting a special adductor indicis. *Nycticebus* presents us with the intermediate state of this muscle, between the foot arrangement, to be referred to presently, and the typical human arrangement; for in this animal the accomplished anatomists who have given us so complete a monograph upon its myology have described, besides the typical interossei, fine fasciculi arising from the third and fourth metacarpals and inserted into

the pollex: these are differentiated fasciculi of the muscles utilized for an important special purpose.

The annularis or ring-finger has in man its palmar radial muscle developed as the second palmar interosseus; and the palmar ulnar, which arises generally from the unciform bone, is shifted in its insertion, into the first phalanx of the little finger, and constitutes the flexor brevis minimi digiti. For the little finger the radial palmar muscle is developed in man and the quadrumana as the third palmar interosseus; and as such it exists in the armadillo. The palmar ulnar muscle is developed into an abductor minimi digiti in the human hand: this fact was first noticed in the case of the *Ornithorhynchus*, by Meckel; but it will be found equally true in man, the cat, and in such of the quadrumana as I have examined.

The pedes of vertebrate animals, both mammalian and reptilian, exhibit a corresponding series of muscles. Taking the human foot as an example, we find for the tibial side of the hallux a muscle, the abductor pollicis, or at least its calcanean head, which is found in quadrumana, many carnivora, and marsupialia. On the fibular side a corresponding muscle, the flexor brevis pollicis, occurs, a muscle whose single origin indicates that it is not the complete representative of its synonym in the hand. This muscle is absent in some monkeys, as the mandril, but large in others, as *Macacus*. The second toe has its tibial muscle circumstanced like its fellow of the manus, and is thus modified into the adductor hallucis, a muscle which is the undoubted representative of the deep head of the hand flexor. From the fibular side of the second metatarsal we find what should be the outer of the plantar muscles modified into the first slip of the musculus transversus pedis, and crossing the metatarsal bone to be inserted into the outer sesamoid bone of the hallux; the remainder of this transversus is made up of the fibular interossei of the third, fourth, and part of the fifth uniting and running transversely: its obvious manus representative is the adductor pollicis, to which there is very often an accessory fasciculus from the fourth metacarpal superadded, as noticed by Huxley (*loc. cit.* p. 538). The tibial interossei of the third, fourth, and fifth toes remain in man unchanged, as the first, second, and third plantar interossei respectively; of these the two last named exist in *Ceroopithecus* and *Macacus*, but the first in these animals is either prolonged as a rudiment of the transversus pedis or absent altogether. The flexor brevis minimi digiti is made up of the remainder of the last fibular muscle that is not required for the transversus.

The plantar interossei having thus been accounted for in man, it only remains to refer to their types the muscles in those

animals already noticed as instances of a greater degree of complexity than usual—the *Hyrax*, *Nycticebus*, &c.; and in all these we merely see approximation to the true type, in various degrees of distinctness. The long muscles in *Hyrax* are probably displaced dorsal interossei, and the short interphalangeal muscles of *Nycticebus* may belong to the same type.

The last class of muscles in the manus which are specially devoted to produce the movements of the digits is that of the dorsal interossei. These we usually find to be bicipital; and accepting this appearance as an evidence of the coalescence of two muscle-germs, we can easily allocate these muscles to their respective places. As extension is a much simpler act than flexion, the latter being liable to endless modifications in grasping, &c., so extensor muscles are much less disposed to vary than flexors. Taking, again, the hand of man as an example, we find the radial dorsal muscle of the pollex present as the abductor pollicis exterior of Sömmerring. The ulnar dorsal muscle constitutes the polliceal origin of the first dorsal interosseus, whose thumb insertion is obsolete. For the index finger the radial dorsal muscle is developed as the first dorsal interosseus; this muscle in *Macacus nemestrinus* has no polliceal; but it is bicipital in *Simia* and in the hyæna and dog. The ulnar dorsal muscle constitutes the outer head of the second interosseus. For the middle finger the dorsal radial muscle forms the medial head of the second dorsal interosseus, and the ulnar makes the corresponding head of the third dorsal of the human hand. In the ring-finger the radial muscle is modified into the annular origin of the third dorsal interosseus, and the ulnar constitutes the annular origin of the fourth. For the little finger the radial muscle forms the ulnar head of the fourth dorsal interosseus, and the ulnar forms the opponens minimi digiti.

The pes exhibits an equally regular series. For the hallux the dorsal tibial muscle is developed as the second head of the abductor pollicis, and the dorsal fibular as the inner head of the first dorsal interosseus. The second toe has its tibial muscle in the form of the outer head of the first external interosseus, and its fibular as the inner head of the second dorsal: this muscle differs from its fellow in the manus in being inserted into the second instead of the third finger. For the third toe the tibial muscle constitutes part of the second dorsal interosseus, and the fibular that part of the third which is attached to the third metatarsal bone. Similarly the two dorsal muscles for the fourth toe constitute respectively parts of the third and fourth external interossei. For the little toe the tibial muscle

forms the second head of the fourth dorsal, while the fibular constitutes the abductor minimi digiti.

Thus we find that all the muscles of the manus and pes may be reduced into a regular ordinal series. The only supplemental muscles to these are the lateralizers of the metacarpals, of which two are usually present:—one an opponens of the metacarpal of the thumb, often present as an accidental variety in the pes; and secondly the lateralizer of the fifth metatarsal bone, present in the foot as the “abductor ossis metacarpi quinti” muscle of Wood, Huxley, and Flower. Perhaps there may be a complete series of these in a typical limb; but I am not aware of any others being present in any individual animal.

XL.—*Descriptions of two New Species of Humming-birds.*

By JOHN GOULD, Esq., F.R.S.

Eriocnemis smaragdinipectus.

Head and upper surface dullish grass-green; rump and upper tail-coverts resplendently luminous yellowish green; on the throat a patch of violet-blue; thence to the vent glittering grass-green; under tail-coverts bright blue; thighs thickly clothed with white downy feathers; bill, primaries, and tail-feathers black.

Total length 4 inches, bill $1\frac{1}{8}$, wing $2\frac{1}{8}$, tail $1\frac{1}{8}$.

Hab. Ecuador.

Remark.—This species, which is from the neighbourhood of Quito, is very closely allied to *Eriocnemis vestita*, but differs from that bird in the green of the breast commencing immediately below the blue throat-spot, whereas in fine old males of *E. vestita*, when viewed in bright sunlight, a black band is seen separating the two colours. It is true that this band is green in certain lights; but the feathers are of a different structure to those of the Quitan species. Taking the average of seven specimens of both kinds, I find the *E. smaragdinipectus* has a rather longer bill and somewhat shorter wing than the *E. vestita*; in all other respects their dimensions are very similar. The green of the abdomen of the former is more pure, or not so yellow as the same part of the latter; in the gorgeous colouring of the rump perhaps the Quitan bird is somewhat less resplendent than the Bogotan *E. vestita*. I have ample materials at my disposal for determining the distinctness of the two birds; and, however similar they may be, there are sufficient tangible characters by which each may be recognized, and to show that they are really different.

Gouldia melanosternon.

Crown of the head, neck, and breast glittering yellowish green, the feathers of the lower part of the neck very obscurely edged with coppery brown; chest jet-black, on each side of which the feathers are light brownish grey, separating the black of the chest from the green of the flanks; under tail-coverts brown and grey; back, rump, and upper tail-coverts bronzy green, interrupted by a band of white across the rump; tail long and deeply forked, the feathers almost filamentous, the outer one on each side grey, the remainder steel-blue with white shafts; bill and wings black.

Total length $4\frac{1}{2}$ inches, bill $\frac{1}{2}$, wing $1\frac{5}{8}$, outer tail-feathers $2\frac{1}{2}$.
Hab. Peru.

Remark.—Very closely allied to *Gouldia Langsdorffi*, but differs in being a trifle smaller, and in the almost total absence of the band across the chest, which forms a conspicuous and beautiful feature in that bird. I have numerous examples of both sexes of this new species now before me, among which are three males, one from the Napo, another from Pebas, and a third from, I believe, the neighbourhood of Ucayali (Bartlett, No. 1619). The habitat of *G. Langsdorffi* is, as every one knows, the neighbourhood of Rio de Janeiro, in Brazil.

XLI.—*List of Coleoptera received from Old Calabar, on the West Coast of Africa.* By ANDREW MURRAY, F.L.S.

[Continued from ser. 3. vol. xx. p. 323.]

[Plate IX.]

Lycidæ.

LYCUS, Fab.

§ 1. Males with elytra expanded, and shoulders prominent but not spined.
Females comparatively narrow.

1. *Lycus foliaceus*, Schön. Syn. Ins. iv. App. p. 26, pl. 5. f. 4, ♂.
Pl. IX. fig. 1.

Lycus oblitus, Dej. Cat. 110, ♂.

There are three types of the male of one of the forms of this section of Lycidæ, which I separate with hesitation and doubt, the more so that I have been unable to find corresponding females for them. Still there are sufficient differences to warrant their being recorded as distinct varieties; and those who do not think the differences specific will suffer little inconvenience in having to rank them merely as known and marked varieties.

The first is that figured and described by Schönherr, under the name of *foliaceus*. It is the *oblitus* of Dejean; and the male is easily recognized from those of the allied species by its large size and the great degree of expansion and inflation of the elytra, and by the apical black mark on the elytra not extending across in nearly a straight line in front, but protruding forwards in three more or less curved, ill-defined breaks in each, the outer black mark being marginal and reaching further forward than the two inner ones, as shown in Pl. IX. fig. 1, which represents the male. The suture is concave towards the apex of the elytra, and the sutural angle ends in an incurved sharp point, as shown in fig. 1, *b*.

In none of the *Lycidæ* of this group is much attention to be paid to the colour of the underside of the body or of the limbs or basal articles of the antennæ. In this species the underside is yellow, and the legs black; but in some the body is brown; and in others the femora are yellowish,—considerable variation occurring in the depth and intensity of the colour.

This species is usually considered the same as the next; but I have found the above characters pretty constant, although in the colouring there are undoubtedly indications of transition between them, inasmuch as the anterior line of the black apical patch in the next species shows sometimes breaks which, if continued, would produce that of this species; but I have never been able to find a regular uninterrupted series of gradations between the two.

One argument in favour of their being distinct is that I have only received some half dozen specimens of this species, and these all in one *envoi*, whereas in all the other collections sent the following species has been numerous.

2. *Lycus immersus*. Pl. IX. figs. 2 (♀) & 3 (♂).

Lycus xanthomelas, Schön. Syn. Ins. iv. App. 26, pl. 5. fig. 5, ♀.

Niger, supra flavus, elytris postice nigris. *L. foliaceo* similis, sed minor. ♂. Elytris minus inflatis, macula apicali nigra majore cum margine anteriore fere recto.

♂. Long. 6–9 lin., lat. 5–7 lin. ♀. Long. 5½–8 lin., lat. 2–3 lin.

Smaller than *L. foliaceus*, differing in the form of the black apical marking on the elytra, it being nearly straight in front, or only extending very slightly further along the margin than in the middle. The inflation of the elytra differs also a little in shape, being broadest a little behind the middle, while in *L. foliaceus* the expansion is nearly oblong oval, and widest in the middle. The termination of the sutural angle is different, being sinuate, as shown in fig. 3 *b*, instead of incurved as in

L. foliaceus, or straight as in *L. semiamplexus*, or rounded incurved as in *L. dentipes*.

The female specimens seem most of them to correspond with this in size, and came along with them and in equal numbers; therefore I have presumed them to be the female of this, rather than of the typical *L. foliaceus*. Fig. 2 represents one of these females. They are the *L. xanthomelas* of Schönherr.

3. *Lycus aspidatus*. Pl. IX. figs. 4 & 5.

Niger, supra flavus, elytris postice nigris. *L. immerso* affinis.

♂. Elytris umbone dorsali prominente, dimidio posteriore nigro, et sutura apice incurvata dignoscitur. ♀ ignota.

♂. Long. $7\frac{1}{2}$ lin., lat. $5\frac{3}{4}$ lin.

Allied to *L. immersus*. Elytra in the male distinguished by a prominent dorsal umbo. The apical black patch extends over fully the half of the elytra, and embraces the umbo. The suture is incurved and slightly sinuate at the apex, and has the angle blunt.

Only one specimen was received.

4. *Lycus semiamplexus*. Pl. IX. fig. 6.

Niger, supra flavus, elytris margine posteriore nigro. *L. immerso* minor, textura læviore; ♂ macula apicali nigra marginem posteriorem elytrorum amplectente et super suturam breviter ascendente, sutura angulis apicalibus rectis.

♂. Long. $5\frac{1}{2}$ – $6\frac{1}{2}$ lin., lat. 4 – $4\frac{1}{2}$ lin. ♀? Long. 6 lin., lat. $2\frac{1}{2}$ lin.

♂. Still smaller than *L. immersus*, and very constant in size; rounder behind than it. The reticulations are finer, smaller, and the texture rather closer; and the form of the black apical mark on the elytra is different, extending in a well-defined narrow band more than halfway along the outer margin, and also encroaching in an oblong patch on the suture, as shown in Pl. IX. fig. 6; in other respects the colouring is the same. The suture is straight, and its angle right-angled and a little rounded or blunt at the point (fig. 6).

I have no doubt that this is distinct from any of the preceding; the size, distribution of colour, straightness of the suture, and fineness of texture are very constant. I have, however, no certainty about the female.

5. *Lycus dentipes*, Schön. Syn. Ins. iv. App. p. 25.

Pl. IX. figs. 7, 7a, & 7b.

Lycus Brenei, Bohem. Ins. Caffr. i. p. 427 (haud Guér. Lefebvre, Voy. en Abyss. pl. 8. figs. 7–9, et Rev. Zool. 1847, p. 223).

Niger, supra flavus; thoracis disco (medio et postice), scutello,

humeris elevatis totis elytrorumque apice irregulariter nigris; abdomine lateribus late flavis.

♂. Elytris amplissimis, conjunctim fere orbiculatis, humeris oblique valde elevatis, femoribus tibiisque quatuor posterioribus dentatis. Long. 10–14 lin., lat. 8–10 lin.

♀. Elytris subparallelis; costa humerali rotundatim et horizontaliter extensa; pedibus muticis. Long. 10–14 lin.

There is no doubt that this is the species described by Boheman as the *Bremei* of Guérin. But he cannot have seen the original figure of that species given by Guérin in Lefebvre's 'Voyage en Abyssinie,' which is quite different from it, and much nearer *L. foliaceus*, or rather that form of it (whether species or variety) which I have above characterized as *L. immersus*. The reference which Boheman gives is to Guérin's separate description in the 'Revue Zoologique,' where there is no plate; but a figure of it is given in Lefebvre's 'Voyage,' of which the entomological part is by Guérin-Ménéville. To remove all doubt from the subject, I figure both. Figs. 12, 13, and 14 (see *L. Bremei* postea) are taken from the plates in Lefebvre's 'Voyage,' and represent Guérin's *Bremei*. Fig. 7 represents Boheman's *Bremei*.

But although the latter is quite distinct, it is not new. Schönherr had previously described it under the name of *L. dentipes*, as may be seen from his description, which is as follows:—

"Niger, thoracis lateribus elytrisque latissimis flavis; his macula basali apiceque nigris; femoribus posterioribus dentatis.

"Habitat in Cap. Bon. Spei. Mus. Schönh.

"Perhaps only the male of *L. rostratus*; the size of the body and the facies nearly as in it, viz. the disk of the thorax almost entirely black, the elytra with a large basal patch at the scutellum, and the apex sinuately black; to be sure, it is larger, and chiefly in the elytra almost twice as broad, competing with *L. foliaceus* in magnitude. The elytra behind the middle very much dilated, with the lateral margin reflexed. The shoulders very much raised, inflated; the suture not infusate. The body below black; the abdomen with the sides luteous. Legs strong and black; the posterior thighs armed below with a strong subobtusate tooth. The wings pale, with the apex black."

The above, with one exception, is a perfect description of the present species: the exception is, "the elytra behind

the middle very much dilated" (elytris pone medium valde dilatatis). It is true that they are very much dilated behind the middle, but so are they before the middle; and if the meaning were "very much dilated, most so behind the middle," then it would be correct; but I rather incline to treat this as an inaccurate turn of expression. There is no African *Lycus* that I know of, except this, which has any of the thighs toothed.

A single male of this species is all that I have seen from Old Calabar. Boheman's description was made from specimens taken by Wahlberg near the River Limpopo; so that we have here the same species apparently ranging across the whole continent. The Abyssinian habitat, resting on its being the species described by Guérin, must be cancelled.

6. *Lycus subcostatus*. Pl. IX. fig. 8.

♀. Niger, supra flavus; thoracis disco, scutello elytrorumque apice nigris, lateribus abdominis flavis vel piceis; elytris sublinearibus, quadricostatis, costa secunda et quarta magis quam ceteris elevatis, humeris horizontaliter costatis.

Long. $5\frac{1}{2}$ lin., lat. $2\frac{1}{2}$ lin.

♂ ignotus.

Similar in appearance to the female of *L. immersus* or *foliaceus*, but with the following differences:—the disk of the thorax black; the elytra with four costæ slightly raised, the second raised a good deal more than the rest, and the fourth next in degree; the shoulders slightly expanded, not tumid, but flat, and with the margin costate; the black apex of the elytra narrowest at the suture. The antennæ are broader than in *L. foliaceus*, and with a tendency to flabellation. Male unknown.

Only one specimen received.

7. *Lycus scapularis*. Pl. IX. fig. 9.

L. palliato affinis et similariter coloratus; elytris longioribus, humeris parum minus inflatis; subtus fuscescens et abdomine testaceo.

Long. 8 lin., lat. $3\frac{1}{2}$ lin.

Closely allied to *L. palliatus* of Fabricius and to *L. palliolatus* of Schönherr, which are probably, as the latter divined, male and female of the same species. This is still longer and proportionally narrower than either, and has the underside fuscous, except the abdomen, which is testaceous instead of black; the shoulders are more restricted in their inflation; the

apex of the abdomen is dark. It is doubtless the Old-Calabar representative of that Senegalese species.

Only one specimen received.

8. *Lycus Bremei*, Guér. in Lefebvre, Voy. en Abyss.
Zool. p. 287. Pl. IX. figs. 10-14.

Lycus dissimilis, Bertoloni, Illust. Rer. Nat. Mozamb. 35, pl. 2. fig. 5, and
Comment. Acad. Bonon. 1849, x. 413.

♀. *L. immerso* (♀) similis, minor, angustior; thorace magis elongato, disco fusco vel nigro; elytris magis parallelis, humeris vix prominentibus.

Long. $4\frac{1}{2}$ lin., lat. $1\frac{1}{4}$ lin.

♀. Like a small female of *Lycus immersus*, and not unlike a small specimen of *L. sinuatus*, only the elytra not so rapidly attenuated behind. The thorax, however, is more elongate, being somewhat gable-shaped; the posterior angles do not project laterally so much, and the disk is piceous or black. The antennæ have a greater tendency to flabellation. The scutellum is piceous or black; the elytra narrower, without humeral projections, and with a coarser reticulation; the apex more attenuated.

In a paper by Bertoloni, entitled "Illustratio rerum Naturalium Mozambici," published in 1849 in the Comment. Acad. Bonon. x. p. 413, there is a species of *Lycus* described and figured under the name of *L. dissimilis*, the female of which agrees with the specimen from which I have taken the above description; but on comparing Bertoloni's figures and description with Guérin's of *Bremei*, which I have here copied (Pl. IX. figs. 12 & 13 from Guérin, and fig. 14 from Bertoloni), it seems to me that the two are the same. Guérin's publication being the prior, his name must stand.

It will be seen, from the above figures, that the form of the expansion of the elytra in the male of Guérin's figure is different from that of *immersus*.

I have only received one specimen of this; and it being a female, and somewhat immature, and the females of the allied species of this group being so like each other, I should wish the reader to receive my determination of *L. Bremei* as an inhabitant of Old Calabar with a point of doubt, and as requiring confirmation.

9. *Lycus pyriformis*. Pl. IX. fig. 15.

Subpyriformis, niger, thorace et elytris supra flavis; thorace medio, scutello et elytris regione scutellari et apice interne

sinuatum nigris, his rugoso reticulatis, quadricostatis, costa humerali parum elevata, lateribus parum reflexis.
Long. 5-6 lin., lat. 4 lin.

Subpyriform in outline, black; antennæ rather stout and with the articles rather short. The thorax is rounded in front, with a black longitudinal band (widest behind) up the middle; the scutellum black. The elytra flat, except at the shoulders; the scutellar region black; the shoulders slightly raised into a narrow sharp ridge, up to which the black comes, but does not touch it; there is a broad black band along the apex and posterior half of the elytra; the margins are sharply reflexed; there are four costæ, which are most pronounced at the base, almost disappearing at the apex. Abdomen black, with the sides broadly yellow. The pyriform outline, the thorax nearly rounded in front, the elytra flat, the scutellar space black, and the margins of the elytra reflexed are the most important characters of this species.

I have received specimens of this from the Cape, under the name of *L. rostratus*, Fab. If, however, the *Lycus rostratus* of Fabricius is the same as the *Lycus rostratus* of Linnæus (which I presume it is), then my specimens have been incorrectly named; for they are certainly distinct from the figure and description of *L. rostratus* of Linnæus (*Lampyrus rostratus* Linnæi) given by Wulfen, in 1786, in his 'Descriptiones quorundam Capensium Insectorum,' of which fig. 16 is a copy. The truth seems to be that the name has been bandied about, by the earlier authors, among any of the African species which had the scutellar region black. There are not many of them. Schönherr supposes *dentipes* to be the female of it, in which I do not agree. The texture is different, that of *dentipes* being somewhat shining, that of the present species dull and pubescent.

10. *Lycus ustus*. Pl. IX. fig. 17.

Niger, thorace lateribus et elytris, exceptis regione scutellari et marginibus exterioribus posticis, flavis.
Long. 6 lin., lat. 3 lin.

Rather narrow, black below, above orange-yellow, with a broad stripe down the middle of the thorax, the scutellum, the scutellar region, and the exterior margin of the posterior half of the elytra black; not so peaked behind as *L. sinuatus*, nor so pubescent.

Not unlike *L. pyriformis*; but, besides differing in shape and colouring, the elytra are not so flat, and have not the margins reflexed.

One specimen; probably a female.

§ 2. Males with a projecting blade on the shoulder terminating in a spine. Females narrower, and with the projecting blade rounded off and without a spine. (See Pl. IX. figs. 18 & 18*.)

11. ♂. *Lycus præmorsus*, Schön. Syn. Ins. App. p. 25, pl. 5. fig. 1; Westwood, Introd. to Entomol. i. p. 254, fig. 27 (6).

♀. *Lycus latissimus*, Schön. *ibid.* fig. 3.

Var. *L. harpago*, Thomson, Arch. Ent. ii. 76; Lacord. Genera Col. pl. 45. fig. 3.

I know of at least four varieties of *Lycus præmorsus*.

Var. *α. præmorsus* (type). The typical form, figured by Schönherr and Westwood, in which there is no median black band across the elytra, but merely two marginal spots and the apical one. This variety has the emargination of the apex of the elytra very distinct. The underside is said by Schönherr to be black.

This I have not received from Old Calabar.

Var. *β. harpago*. The *Lycus harpago* of Thomson, which appears to be only a variety of *præmorsus*. He says it is very nearly allied to it, but differs by its size being greater, by its elytra being more strongly dilated, by the median band being complete, by the truncature not being so strongly spined, and by its yellow abdomen. Now, as to its size, the difference is too slight to allow that alone to be reckoned as a distinctive character; and I have specimens agreeing in all other respects with the characters of *L. harpago*, but no larger than Schönherr's typical *præmorsus*. Indeed the only difference between one of the Old-Calabar varieties of *præmorsus* and the figure of *harpago* in Lacordaire's 'Genera des Coleoptères' is that it is somewhat smaller. Next, as to the elytra being more dilated, this is the case in my own larger specimens, but not in the smaller. It is a character, or perhaps a *deceptio visus*, arising from the increased dimensions. The median band, although styled by Thomson complete, is not complete in Lacordaire's figure, but only interruptedly complete, the two large, broad median marginal patches being only semiunited by a much narrower, black, irregular line, of diverse thickness, interrupted in two parts. I have specimens, both male and female, with the band exactly so interrupted, and others not interrupted at all, others without the uniting line at all, and another with about the whole of the latter half of the elytra invaded by black. This extension of the black colour across the elytra cannot, therefore, be regarded as a character of much importance. The truncature of the apex of the elytra being more feebly emarginate is also a small character; and I should scarcely like to say that in my specimens it was more feebly emarginate; in the next

variety it certainly is. The last distinguishing character is that Schönherr describes the underside as black, while Thomson's *harpago* is yellow, except the terminal segment of the abdomen. This difference is, I suspect, not one in the insects themselves, but due to the process of drying. My reason for suspecting this is that the underside, on a slight examination, appears to be yellowish in many of my specimens, piceous yellow in some, and black in others; but, on a more careful examination, I can see a yellowish tinge shining through both the brown and the black; so that there is little doubt that they have all been more or less yellow in life, and have acquired the darker hue either from having been in spirits before being dried, or through the process of drying itself.

This variety occurs at Old Calabar.

Var. *γ. subdenticulatus*. A variety still larger than any of my specimens of *harpago*, in fact almost as large as the figure of it given by Lacordaire, but with the band wholly interrupted, exactly as in the typical *præmorsus*. It has, however, the apical truncature much less emarginate; and the little tooth at each corner of the emargination in *præmorsus* is here almost entirely absent, particularly at the external angle. In this respect and in their size my specimens would agree better than the preceding banded variety with *harpago*; but this only seems to furnish additional proof that they are all varieties of one species.

This variety also occurs at Old Calabar.

Var. *δ. fenestratus*. In this variety the apical and median black bands have coalesced, leaving only a small spot or two of yellow surrounded with black.

This is a variety of which I have a single female from Old Calabar.

Many specimens have been received of the variety which I have called *subdenticulatus*; only a few of the variety with a median band.

12. *Lycus Æolus*. Pl. IX. fig. 19.

Capite nigro, thorace subtus nigro, supra aurantiaco, disco longitudinaliter nigricante; metasterno nigro, postice flavescente; abdomine flavo, medio fusciscente, apice piceo-nigro; elytris aurantiacis, apice et lateribus posticis nigris, humeris breviter armatis, lateribus expansis tumidis; antennis pedibusque nigris.

Long. 8 lin., lat. 6 lin.

The head black; the thorax above orange-coloured, with the disk brownish black, and beneath black; the scutellum dark, and the elytra bright orange-coloured, with the apex

and posterior margins broadly black; the metasternum black, with a yellowish space in front of the trochanters of each of the hind legs; the antennæ, parts of the mouth, wings, and legs black. Antennæ moderate. Thorax with the sides broad, and the middle space in front projecting triangularly over the head; anterior angles rounded, posterior slightly acute. Elytra with the humeral blade short and flat, the spine or point in the male short, and its angle obtuse and only slightly curved; two strong costæ run down in the space between it and the suture; and on the outer side the elytra expand, leaving a defined line marking the point of the expansion; and this expansion is anteriorly swollen, like the cheeks of *Æolus* (whence I have derived its name), broadest before the middle, sloping obliquely backwards; and the black apical margin is as broad as this swollen portion. In the male the suture is incurved in its posterior half, and the apex of each elytron is truncate obliquely and with a slight curve inwards, the outer angle rounded, and the sutural angle is nearly right-angled. From the analogy of the next species, *L. elegans*, which is nearly allied to it, I presume that the apex of the elytra in the female is rounded to the suture, and not truncate, and that the suture is straight in the female.

A very handsome species, the rich orange-colour and deep black making a fine contrast.

Rare. I have only received two males; but I have seen one or two others, from the west coast of Africa, in the British Museum and other collections.

13. *Lycus elegans*. Pl. IX. fig. 20.

L. Æolo affinis, sat similiter coloratus, sed elytrorum lateribus postice angustius nigro notatis et elytris magis elongatis et lateribus minus tumidis.

♂. Long. 8-9 lin., lat. $5\frac{1}{2}$ lin. ♀. Long. 10-11 lin., lat. 5 lin.

Allied to *L. Æolus*; but the black margin near the apex is much narrower, and cannot be said to extend along the apex; for its inner side starts from the sutural angle, and from that part it runs parallel to the outer margin for nearly the half of the elytra (less in the female than the male); the colouring in other respects is nearly the same, except that the metasternum is wholly black, and the abdomen all yellow, except the last segment. In shape, however, and general appearance it differs more materially. It is a larger, longer, and more elegantly proportioned insect. The thorax is more transverse and

squarer, and the triangular projection of the middle over the head is not so great and is wider; the posterior angles are rounded at the points and channelled. The elytra are widest about the middle, and slope more gently both backwards and forwards; the swollen lateral expansion is longer, narrower, and not so tumid; the humeral blade is longer; the suture in the male is curved concavely behind the middle, and the apex truncate obliquely, terminating at the sutural angle in a sharp little yellow tooth; in the female the suture is straight, and the apex rounded ovately; tibiæ simple.

This I think the handsomest of the West-African Lycidæ. It is apparently rather rare, not many specimens having reached me.

§ 3. Elongate, attenuate at the apex; the elytra in neither sex expanded nor armed with blades or spines on the shoulders.

14. *Lycus sinuatus*, Schön. Syn. Ins. iv. App. p. 28.
Pl. IX. fig. 21.

Of this I received several specimens, divisible into two groups, one larger than the other, and with longer and proportionately more slender antennæ: they were, doubtless, the sexes, the one with longer antennæ probably the male. The abdomen in some is black, but in most is slightly margined with yellow; and the median black stripe on the thorax is broader in some than in others.

[To be continued.]

XLII.—On Ellipsoidina, a new Genus of Foraminifera*.

By GIUSEPPE SEGUENZA, Professor of Natural History in the Royal Lyceum, Messina. *With further Notes on its Structure and Affinities*, by HENRY B. BRADY, F.L.S., F.G.S.

[Plate XIII.]

[A portion of the following translation was prepared some years ago; but the difficulty of accepting the author's conclusions, without some modification which there was then no means of verifying, caused it to be laid aside. Quite recently I have received from Professor Seguenza a number of specimens, the careful examination of which has led to results differing in one or two important particulars from those detailed in his paper,

* From the 'Eco Peloritano, Giornale di Scienze, Lettere ed Arti,' Anno v. serie 2^a. fasc. 9.

and more in accordance with the phenomena observable in allied Foraminifera. His introductory observations seem of sufficient general interest to warrant reproduction: the paper has therefore been translated entire, with the exception of the concluding portion (referring to specific subdivision), which is based upon views since abandoned by the author. The notes and supplementary matter are placed at the end as an appendix.—H. B. B.]

“Natura maxime miranda in minimis.”—*Linnaeus*.

“BEFORE the celebrated Italian, Soldani, had commenced his elaborate researches upon the microscopic creatures now known under the name of *Foraminifera*, several other authors had mentioned them in their writings, *e. g.* Beccarius*, Plancus†, Gualtieri‡, Ginanni§, Ledermüller||, and others; yet it was Soldani who, by close and persevering study, opened an unlimited field for future discovery by the publication of his widely celebrated works¶.

“Subsequently the immortal Linnæus, by classifying them amongst other animals, endowed these little beings with scientific importance—an importance further increased by the work of Fichtel and Moll**, published in 1803, in which the Foraminifera are well illustrated and described. Accumulated observations afterwards opened the way for the dismemberment of the large genus *Nautilus* of Linnæus, which was effected by Lamarck†† and Montfort‡‡.

“The indefatigable Alcide d’Orbigny followed, and, by his unremitting labours and accurate observations upon these little animals, succeeded in forming his ‘Tableau des Céphalopodes,’ by classifying in genera all the known species, together with those he had himself discovered. Till then it had been firmly believed that these microzoa were Cephalopoda, because they are provided with many-chambered shells, as some Cephalopods are; and the observations of M. d’Orbigny up to that time only confirmed this idea. Alas! to what great mistakes anticipation may lead! We may from this error learn how much impartiality and accuracy is needed in every kind of observation, and especially in those pertaining to microscopical

* De Bononensi arena (Comment. Acad. Bonon. i. p. 68).

† Ariminensis, De conchis minus notis. 1739.

‡ Index testarum conchyliorum. 1742.

§ Mare Adriatico, opere postume. 1757.

|| Amusements microscopiques. 1764.

¶ Saggio orittografico, ovvero ec. 1780, e Testaceographia.

** Testacea microscopica &c.

†† Animaux sans Vertèbres.

‡‡ Conchyliologie systématique. 1803.

science. But it was given to the celebrated M. Dujardin to discover the simplicity of the organization of these animalcules, and to demonstrate that they are only formed of a fleshy mass, resulting from the coalescence of numerous filaments, and filling a calcareous shell, through the pores of which the filaments pass, performing the office of locomotive organs. By reason of the great simplicity of their structure, they were placed amongst the lowest of the zoological series, near the zoophytes.

"De Férussac would not bow to the clear and well-proven discovery of Dujardin, but adhered to the former belief. Not so D'Orbigny, who, struck by the clear light of the newer views, gave up his opinion to adopt them, and, devoting increased attention to the Foraminifera still living in the sand of our seas, as well as to those which have left their shells in the rocks formed from marine deposit, established a methodical classification which is still followed, and compiled many interesting and valuable treatises, amongst which are numbered those in which he gives his observations on the Foraminifera of the Canary Islands and of South America, of the fossils of the white Chalk of Paris and of the Tertiary basin of Vienna, together with other valuable memoirs.

"Numerous other zoologists have continued the investigation of this class of Radiata, amongst them Deshayes and Michelotti, and more recently Reuss, Czjzek, and Costa, who, pushing forward in an unlimited field, have by their researches added many new facts to the interesting science of minute life.

"Whilst zoologists by their researches have settled the position of these Radiates, they have not been of one accord as to the name to be assigned to them; and science has been retarded by the useless differences that have thereby arisen. Thus Blainville called them *Bryozoaires*; Dujardin, *Rhizostomes* or *Simplectomères*; Deshayes, *Polypodes*; Michelotti, *Rhizopodi-Foraminiferi*; Menke, *Trematophores*; and, finally, D'Orbigny used the term *Foraminifères*, which denomination has been adopted by modern writers.

"Although animals of this class are endowed with extreme minuteness, they are equally remarkable for the immense multiplication of individuals, so that a handful of our sea-sand may contain several thousands of specimens; and not only do they manifest themselves in such large numbers in the present geological period, but they must have existed to even greater extent in the Tertiary epoch, to have formed the numerous rocks and extensive strata which in certain places are built up of their fossil shells. And though not a few writers have described the Foraminifera of particular beds, if we consider how

limited in number are the localities explored in comparison with those still to be worked out, we must believe that palæontology is still to be enriched by countless new species, and within a few years it must record in its annals many fresh genera and novel facts concerning them.

"Our own island of Sicily, which has been but little searched by the palæontologist, has been still less studied in respect to its Foraminifera; in fact nothing is known concerning them, except the few species mentioned by Sig. Hoffmann and repeated by Calcare, and those recently discovered by Prof. O. Costa, of which the names alone are given in his 'Paleontologia del Regno di Napoli.' Yet the number of their calcareous shells occurring in the Tertiary beds of Sicily is very great, and the variety of species, recognizable by their fossil remains, considerable.

"In my palæontological researches in the district of Messina, I have frequently met with enormous Foraminiferous deposits; and from them I have already obtained the fossil shells of about three hundred species, which in the course of their successive discovery have confirmed my belief in the existence of Miocene strata on the two opposite sides of the Peloritian chain*. Their general characters and similarity to species already known yield a strong support, an undeniable evidence, and a clear argument in favour of my views of the geological structure of the neighbourhood of Messina. The object of the present memoir is to describe a new generic form of these minute shells, which I have observed in the Miocene marls of the locality alluded to.

"Amongst the numerous beautiful and striking forms I have noticed there is one which has the external characters of an *Oolina*, perfectly oval or ellipsoidal in shape, and terminating in a tube not showing on its external surface, even under the microscope, any trace of sutural constriction. From these characters I believed it at first to be a Monostegian Foraminifer, in reality an *Oolina*, very much resembling, if not identical with, the *O. ellipsoides* of Costa. On breaking the shell, however, the reality proved to be in complete opposition to the ideas I had formed from its external features. It was seen to consist of a series of chambers, similar in shape but decreasing in size, each succeeding chamber completely enveloping the previous one. The chambers, however, are not concentrically arranged, but each is fixed by the inferior extremity to the base of that which contains it, whilst the extremity of the tube is fixed where that of the exterior chamber commences.

* *Vide* "Del terreno Miocenico osservato sui versanti della Catena Peloritana" (Eco Peloritana, Anno 7, serie 2^a, fasc. 5).

"Such being the structure of the calcareous shell, it may easily be seen that the chambers, besides being of uniform shape, are so arranged that their axes are in a right line, each chamber being altogether closed and fixed at both extremities of its longer axis. It is therefore evident that this Foraminifer belongs to D'Orbigny's order *Stichostegues*. Further, it becomes the type of a well-defined genus, approaching in its structure the *Glandulinae* and *Nodosariae*, but showing the successive chambers completely enveloping each other, whilst in the *Glandulinae* they appear in part projecting to the exterior, and in *Nodosaria* they are placed one on the top of the other, overlapping each other but little, if at all. This will show clearly how well-defined is the new genus, which I name *Ellipsoidina*, and that it is related to *Nodosaria* through *Glandulina*.

"By minute study of these microscopic shells, I succeeded in distinguishing three specific forms belonging to the genus in question; and after I have recapitulated the generic characters, I shall describe the species.

"I was led to adopt the name *Ellipsoidina* in order to preserve the generic terminology of the class, inasmuch as almost all authors who have written on the subject, and especially D'Orbigny, have derived the chief portion of their generic terms from resemblances in external form: hence the name given, referring to the nearly elliptical contour of the shell, is consistent with common usage.

Characters of the Genus.

ELLIPSOIDINA, mihi.

"Shell free, regular, ovato-ellipsoidal, vitreous in texture, terminated at one extremity by a tube, which is closed at the base where it joins the shell. In the interior are a series of chambers similar to the external one, decreasing in size, which successively completely envelop each other, each attaching itself to the base of that which immediately encloses it, and fixing itself to the apex of the same by means of the extremity of the tube.

"*Relations and Differences.*—This genus, as I have already remarked, is closely allied to *Glandulina*, but it has sufficiently distinct characters. The most remarkable fact is that, although *Ellipsoidina* is multilocular, and hence very distinct from the order *Monostegia*, still it is impossible, from exterior appearance, to distinguish it from *Oolina*, so much do they resemble each other externally; indeed the form of the shell, the absence of pores, the elongation of the anterior portion into a tube, the

absence, in short, of every mark that would indicate the plurality of chambers, are characters which accord well with those of *Oolina*, whilst those of *Ellipsoidina* have their origin, as we may readily understand, in the arrangement of the chambers.

"It must still be noted, however, that this genus presents certain peculiarities altogether dependent on the disposition of the various portions of the shell. In general the chambers of a multilocular shell are in direct communication with each other by means of apertures or pores variable in size and form, so that each cell opens into the interior of that which immediately follows it. This is not the case in *Ellipsoidina*, the cells of which have no apertures; and should a perforation be found in the base of the tube at the anterior portion of each chamber, this is not in communication with the succeeding ones, whilst the extremities of their tubes are adherent to the anterior portions of the enveloping chambers.

"*Distribution*.—The three species of *Ellipsoidina*, that up to the present time I have been able to observe, belong to the Miocene epoch, and appear in the marls of many localities around Messina, and not far distant from it."

Then follow the descriptions of three forms differing in little beyond the mere variations of external contour indicated by the trivial names assigned to them—*E. ellipsoides*, *E. oblonga*, and *E. abbreviata*. I gather, from a letter received but lately from Prof. Seguenza, that he has abandoned this subdivision, a conclusion in which, judging by analogy, I should entirely agree; so that it is needless to repeat the details of their supposed differences. The precise localities given are, for the first-named (typical) form, the beds in the neighbourhood of Scoppo, Gravitelli, Scirpi, and S. Licandro, in all of which places it is very common, and those of Masse, in which it is rare. The second form is stated to be found near Scirpi, Scoppo, and Masse, but always rare; and the third at Scirpi and Scoppo, likewise uncommon.

The genus may be regarded, therefore, as represented by one species only, having the following characters:—

Ellipsoidina ellipsoides, Seguenza.

Shell oval, oblong or subspherical; posterior extremity rounded, anterior more or less obtuse, sometimes terminating in an elongate tube-like process, which is either cylindrical or somewhat obconical. Chambers numerous (two to five). Colour white, opaque; young and small specimens subhyaline. Surface smooth. Length $\frac{1}{16}$ to $\frac{1}{8}$ inch.

The Foraminifera brought under notice in the memoir are in a high degree interesting from certain particulars of structure not hitherto recognized in members of the group to which they belong. It is necessary, however, in the first place to notice one or two errors in the description of the genus; and this I am enabled to do (through the courtesy of Professor Seguenza) from observations made upon specimens collected in the Sicilian localities alluded to in the text.

That we have in these beautiful little shells from the Miocene Clays representatives of a new subtypical form of Nodosarian Foraminifera, no one will doubt; but the characters assigned to them would indicate, if correct, not merely generic or sub-generic peculiarities, but rather a plan of growth entirely new to the order. The most important of these is indicated by the statement that there is *no communication between the interior of one chamber and that of the succeeding one*. This is probably intended to mean intercommunication in the ordinary way by a central orifice, though no qualification is made of the broad general statement. Were such a supposition verified, it would necessitate the conclusion either that the animal vacated the smaller chambers as succeeding larger ones were formed, or that the minute foramina existing in the shell-wall were sufficient for the exercise of its functional requirements so far as concerned the intercommunication of the sarcode-segments—suppositions equally without parallel in the economy of species whose shell-structure has been well made out. The difficulty of accepting the relation of parts indicated in the sectional diagram accompanying the original paper led to the observations of which I now give the results.

The normal mode of growth amongst the straight *Nodosarinae* consists in the formation of a straight line of sarcode-segments united by narrow stolons. Each new chamber-wall is produced by the deposit of a calcareous test on a lobe of sarcode issuing from the terminal aperture of the last-formed chamber. Hence each stolon represents the interior of what was in its turn the terminal aperture, and its length depends on the character of the orifice. In some species, in which the mouth does not protrude, the length of the stolon is only as much as the thickness of the shell-wall, whilst in others the chambers are surmounted by a neck nearly equal in length to the main body of a segment. Prof. Seguenza's figures of *E. ellipsoides* show a long terminal neck somewhat of the latter description, as indicated by the dotted lines in figs. 1 & 2, Pl. XIII. Unfortunately no specimen has come under my notice in this condition; consequently my remarks are founded on the corresponding structures in the interior of the shell.

On exposing the interior of the shell, by carefully breaking away the chamber-walls (fig. 4), or on mounting young and transparent specimens in Canada balsam, it is seen at once that the column extending from the apex of the primordial chamber (or sometimes from within it) to the anterior of the terminal segment bears only superficial resemblance to the neck in the chambers of the *Nodosariæ*, and is in no way its homologue: indeed the description of it in the memoir under notice is correct in most of its features. The term "tubular," as applied to it, is apt to mislead; for although in form the column is often cylindrical and hollow, the walls have almost invariably perforations of considerable size, and are often even split up into several smaller and independent portions. Figure 5 is a drawing of one of these divided into three spreading arms; and in fig. 6 the tendency to separate into several distinct members may be well seen. When partaking more of the cylindrical or tubular form, a high magnifying-power and careful regulation of the light will generally show the existence of perforations, longitudinal and slit-like, from which it may be inferred that the column consists of delicate lines of shell-substance associated in perpendicular bundles. This conclusion is further strengthened by the frequent occurrence of surface-irregularities running in the same direction. When the column takes the common and more or less tubular form, its apex is usually swollen at the point where it joins the enveloping chamber, whilst nearer the base little, if any, alteration in diameter is observed; in some instances it tapers regularly down to the point of junction with the inner chamber.

The shell-wall is not, *as a rule*, perforated at either the anterior or posterior extremity within the walls of the column. In the exceptional cases in which an orifice occurs in the portion of the chamber-wall corresponding to the upper end of a segment of the central column, it may or may not form the channel of communication. But the function of the central body is not that of a stoloniferous tube; and when it performs this office (if ever), it arises from casual irregularity in growth. The purpose which it serves is, I believe, purely that of a support for the chambers, which are otherwise so lightly held together that the slightest shake would separate them. The adhesion between the posterior portions of the chambers is scarcely perceptible, and amounts to little more than the mere juxtaposition of surfaces. If Professor Seguenza's figures be drawn from perfect specimens, and not from such as have had the outer chamber broken away, it would follow that the support is formed before the enveloping chamber. The form of the column and its relation to the shell make it improbable

that this is the usual order of growth; and as, in the only two instances I have seen of segments having the central pillar incomplete, the portion formed was attached to the inner surface of the apex of the enveloping chamber, I am disposed to think that, as a rule, this portion of the shell is built up on an entosolenian plan. It occasionally happens (as in fig. 5) that, on breaking a shell, the central column remains attached to the inner chamber, leaving the outer one at its point of union; but this is quite an exceptional case; for in a very large majority of instances the fracture takes place at the opposite extremity. On the other hand, the tendency to entosolenian growth is evinced strikingly in the somewhat anomalous condition of the first and second chambers of a large specimen shown in fig. 11, in which the primordial chamber, containing nothing requiring support, has a rudimentary tongue-like extension of shell-substance from the interior apex. It may be noted, also, that Signor Seguenza figures one of his varieties without any external tube. I suspect, therefore, that, having found in one or two instances an ectosolenic tube arising from the breaking-away of an enveloping chamber, the conclusion has been drawn without further investigation that specimens not presenting this outgrowth were imperfect. I speak with considerable reservation, as none of the specimens which have fallen into my hands had an ectosolenian neck, or indeed any evidence that such had ever existed.

But, recognizing the fact that the central column is not the counterpart of the produced septal orifice seen in many *Nodosarinx*, in other words, that it is not a stoloniferous tube, we have still to find how communication between the chambers is kept up—a matter of greater difficulty than at first sight appears, on account of the extreme brittleness and delicate texture of the shell. The condition shown in fig. 11, being in other respects monstrous, is of little value as an indication that the septal orifice may occur at the summit of the central column; nor is it needful to dwell upon it, inasmuch as I have never seen another example with similar characters. The usual form of the aperture is that of a curved slit, either entire or bridged over here and there, situate at a little distance from the periphery of the column, and to some extent concentric with it. The only two perfect specimens which I have left are almost exactly alike in the aspect of the *exterior* aperture; and fig. 8, drawn from one of them, would answer equally well for either. The projecting tongue of shell-substance in the centre is somewhat raised, and has a valve-like appearance on being viewed more laterally. In figures 9 & 10 the septal orifices of *inner* chambers are shown, one of them with, the other without, the

succeeding internode of the column; whilst figures 6 & 7 show the perpendicular relations of similar structures taken from other specimens. Altogether *Ellipsoidina* differs strikingly in the character of its septal and pseudopodial orifices from other genera of *Nodosarinae*; and it exhibits no tendency to assume the radiate corona, the circular lip, or the pouting aperture common to some portions of the group.

It has been stated that the texture of the shell is singularly delicate. This is especially true of the inner chambers, which have at the same time a roughened surface not easy to account for. It can scarcely be called crystalline; yet it seems to present minute angles which sparkle in a strong light, as though covered with a glistening dust. I can scarcely, without more opportunity for pursuing the subject than I have yet had, offer a satisfactory explanation of this appearance. Circumstances lead me to think that the peculiar condition of surface arises from the partial re-solution of an originally smooth and thicker shell-wall, in the process of supplying the increased requirement for calcareous matter in the formation of the later chambers. The appearance is that of a corroded surface in which crystalline structure or lines of deposit may have been rendered apparent by unequal solution. My friend Dr. Alcock has remarked a subcrystalline condition (which I have also many times observed) in the fistulose outgrowths of *Poly-morphina horrida*; but this is of a somewhat different character, and may be referred to a quite distinct cause.

Another point also I must pass over, equally without comment, for want of sufficient material for definite conclusions. In the innermost chamber of one of the shells which were broken in order to ascertain the internal arrangement, a very minute nucleolar body was found slightly adhering to the interior of the cell-wall. It was a slightly rough, transparent, multicellular, calcareous shell, as represented in fig. 12, and about $\frac{1}{100}$ inch in its long diameter. It apparently had existed, free, in the body of the sarcodæ, and had no structural connexion with the general shell-wall. Without the opportunity of making search in other examples for bodies of the same or similar nature, it would be useless to attempt to define its office.

EXPLANATION OF PLATE XIII.

Fig. 1. *Ellipsoidina ellipsoidea*, side view, $\times 25$ diameters. The neck in this figure and in fig. 2, indicated by dotted lines, and the corresponding portion in the centre of 1^a are inserted on the authority of Prof. Sequenza's drawings.

Fig. 1^a. The same, end view, $\times 25$ diam.;

- Fig. 2. *Ellipsoidina ellipsoidea*, elongate form, originally described as *E. oblonga*.
 Fig. 3. The same, subglobular variety, at first described as *E. abbreviata*.
 Fig. 4. Same specimen as fig. 1, but with the two outer chambers partially broken away so as to show the internal structure; $\times 25$ diam.
 Fig. 5. Inner chamber of another shell, showing the central column (usually more or less tubular) tri-cleft and spreading.
 Fig. 6. Part of a central column dividing near its summit into smaller members, with the portion of the shell-wall immediately above it still adhering.
 Figs. 7-10 are intended to illustrate the form of the external and septal apertures. Fig. 8 is an end view of a specimen without a neck, but otherwise perfect, showing what seems to be the ordinary condition of the external orifice. Fig. 7 is a representation of a similar shell broken down the centre. Figs. 9 & 10 relate to the inner chambers.
 Fig. 11. Abnormally formed primordial chambers of an elongate specimen.
 Fig. 12. Multicellular nucleus found in the primordial chamber of a large example, $\times 180$ diam.

XLIII.—Description of a rare Indian Clausilia.

By SYLVANUS HANLEY, Esq., F.L.S.

Clausilia tuba, Hanley.

Testa (pro genere) magna, subcylindraneo-fusiformis, apicem obtusum versus cylindracea, albido-cornea, unicolor, tenuis, subdiaphana, haud rimata, lineis elevatis vix continuis et (praesertim in anfractu ultimo, ubi remotiores fiunt) oblique corrugata. Anfractus 10-12, sutura profunda et minime crenata divisi; apicales unice convexi, subaequales; caeteri convexi, et satis rapide crescentes; penultimus major, altior; ultimus curvatus, verticaliter descendens, infra suturam submarginatam subcoarctatus, denique insigniter dilatatus, basi rotundata nequaquam cristatus. Apertura permagna, soluta, porrecta, subcordato-rotundata, undique patentissima. Peristoma continuum, late expansum: lamella supera conspicua, angusta, arcuatim subverticalis; lamella infera adjacens, obliqua, magisque profunda; plica subcolumellaris parvula, verticalis; plica palatalis (si sit ulla) labrum haud attingens: lunella opacitate conspicua.

Long. $1\frac{1}{2}$ poll.

Hab. Shan, provinc. Ind. or. Mus. Theobald, Hanley.

I am indebted to W. Theobald, Esq., for this remarkable species, which must closely resemble the American *C. epistomium*. It was taken by Mr. Fedden from the valley of the Upper Salwen.

XLIV.—*Remarks on some Species of Oliva recently described by Mr. Frederick P. Marrat.* By T. GRAHAM PONTON, F.Z.S.

IN the 'Annals,' ser. 3. vol. xx. p. 213, Mr. Marrat published descriptions of twelve new species of *Oliva*. With your permission I would beg to make a few remarks upon some of them.

The genus *Oliva* is one of the most interesting to the student of variation. Colour, which has been so frequently taken as a guide in the determination of specific differences in shells, here almost completely fails. This has been well shown in the fine monograph of the genus published by the late Mr. L. Reeve; and I cannot help thinking that Mr. Marrat has somewhat lost sight of the fact.

For example, the *Oliva violacea* described by him is almost identical with some specimens of *Oliva reticularis*, from Mazatlan, in the Museum of the Bristol Philosophical Institution. These shells have the pale zigzag lines and semilunar dots described by Mr. Marrat. The base of the columella is stained with violet, which, by the way, is a marked character of *O. reticularis*. The interior of the aperture is pale bluish—thus making a decided approach to Mr. Marrat's shell. In fact I cannot help thinking that *O. violacea* is nearer the typical form of *O. reticularis* than some Californian examples of the species in our Museum, which are of a deep brown, marbled with a darker colour; the columella in these examples is of a full, rich brown tint. Similar specimens are figured in Reeve's monograph.

Oliva jamaicensis, Marrat.—This shell, Mr. Marrat remarks, is intermediate between *O. splendidula* and *O. reticularis*. This observation goes far to prove that the opinion entertained by many conchologists respecting the identity of the two species mentioned is a correct one. I cannot distinguish Mr. Marrat's shell from varieties of *O. reticularis* with a depressed spire—a feature which is not uncommon even in very typical forms of the species.

Oliva polita, Marrat.—I cannot help thinking this shell is merely a variety of *O. jaspidea*, which varies much both in form and colour: certainly varieties of that species in our Museum answer well to Mr. Marrat's description.

Oliva piperata, Marrat.—Mr. Marrat remarks that this shell is allied to *O. conoidalis*, Lam. The *O. conoidalis* of Lamarck is simply a variety of *O. jaspidea*. Is not Mr. Marrat's shell the same?

Oliva faba, Marrat.—This shell, Mr. Marrat observes, is

intermediate between *O. todesina*, Duclos, and *O. ispidula*. The *O. todesina* is merely a variety of *O. carneola*, Lamarck, which very variable shell presents every form intermediate between the typical broadly angulated carnelian-coloured specimens and the narrow, oblong, cylindrical, dull-purple, reticulated ones. Some of these varieties are well figured by Reeve; and Mr. Marrat's description of *O. faba* answers well to some of them and to others I have seen.

Oliva blanda, Marrat.—I am much disposed to think that this is but a variety of *O. ispidula*. The more or less swollen condition of the columellar lip is a very variable character: specimens of the white variety of *O. ispidula* present it in a marked degree.

Oliva cylindrica, Marrat.—The description of this shell answers well to the var. α of *O. irisans* figured by Reeve. *O. irisans* is an exceedingly variable shell, and its forms have even not yet been completely worked out.

Oliva pallida, Marrat.—I believe this to be a variety of *O. scripta*, which species is mainly distinguished from some varieties of *O. literata* and *O. reticularis*, which closely resemble it, by its short spire and pale aperture.

Oliva oblonga, Marrat.—Is not this the shell figured by Reeve under the name of *O. fusiformis*?

Oliva truncata, Marrat.—I cannot help thinking this is merely a variety of *O. polypasta*, which, in its turn, I am much disposed to believe is merely a variety of *O. reticularis*, and that it is connected with that species by numerous indefinable variations. The mere circumstance of locality would not in itself be any evidence of specific distinctness. The Olives present many remarkable anomalies in this respect: for example, *O. cruenta* inhabits the Philippines, Zanzibar, Australia, and the Society Islands—widely diverse localities. *O. Duclosi* is found at the Philippines and at the Society Islands. *O. reticularis* occurs in California and in the West Indies—all strangely different habitats.

With respect to Mr. Marrat's other two species, viz. *O. ornata* and *O. similis*, I will say nothing, sufficient evidence being wanting; but I must confess to being somewhat suspicious as to their specific value.

Clifton, near Bristol,
March 30, 1868.

XLV.—Notes on the Remains of some Reptiles and Fishes from the Shales of the Northumberland Coal-field. By ALBANY HANCOCK, F.L.S., and THOMAS ATTHEY.

[Continued from p. 278.]

[Plates XIV., XV., XVI.]

Rhizodus Hibberti, sp., Agassiz.

The teeth of this species have not yet been found in the shales of our neighbourhood; but large scales which appear to belong to it are not by any means uncommon at Newsham and Cramlington. They are rarely found perfect; sufficient examples have, however, been obtained to enable us to identify them with the scales of *Rhizodus Hibberti* described by Dr. Young in vol. xxii. p. 599 of the 'Journal of the Geological Society.' The largest we have seen measures three inches in diameter; they usually appear quite thin, and are of an irregularly rounded form with the front margin a little flattened, the posterior a little produced, and the sides only slightly arched. The surface is marked with numerous sharp concentric lines of growth and minute, close, radiating striæ, requiring a good lens to show them. There are also a few distant delicate ridges, extending from the centre to the anterior border.

Such scales are undoubtedly in an imperfect condition. When complete, they are considerably thicker, and the under surface has a smooth bony appearance, exhibiting nevertheless decided concentric lines of growth, a subcentral elongated boss, and numerous small pits, particularly on the posterior portion, which, however, we have never seen in a good condition. On the posterior or exposed area there are a few obscure, irregular, radiating ridges, which are rendered still more indistinct by the granular tubercles that are scattered over the surface. The smaller scales, which are usually about one inch and three-quarters long and scarcely one and a half inch wide, have all the characters of the large scales; but they are generally more elongated in form, and the minute radiating striæ are coarser.

Besides these scales, several bones have occurred at Newsham, which, from the peculiar surface-sculpture, most probably also belong to this powerful fish. We were anxious to prove this by comparing them with some authenticated fragment of the bone of *Rhizodus* showing the surface-ornament, but have failed in our endeavour. They agree, however, in this respect so well with the descriptions, that we cannot hesitate to assign them provisionally to this species.

Of the two most remarkable bones of this collection, one

approaches in form to the malar of the Alligator, and reminds one somewhat of the bone in *Asterolepis* considered by Agassiz to be a premaxillary*; but in our specimen the articular portion is wanting. The other bone is apparently the posterior part of a mandibular ramus with a wide articular process at the hindmost part, not perfect though very distinctly displayed. The former of these bones is quite four and a half inches long, and upwards of one inch wide at the broadest part; it is thin in front, thickens backwards, and bends rather abruptly down at the posterior extremity, which is broken. Along the under margin there is a wide, flat, thin, squamous process, probably for the articulation of the maxilla; the opposite margin is not perfect; but in a smaller specimen of the same bone a similar flat articular process extends from the upper margin also.

The bone which we suppose to be the posterior portion of a mandibular ramus is nearly five inches in length and one and a half inch wide, including the lateral squamous expansions; it is thin, flat, and rounded in front; behind it is much thicker; and though the posterior extremity is wanting, the greater portion of the articular process is present; it has a wide oblique glenoidal surface. The lateral squamous expansions will undoubtedly articulate with the dentigerous bone.

Other interesting bones have also occurred, some of which can be identified as jugulars. One distorted and folded mass comprises two large jugulars, apparently the pair of principal plates. A considerable portion of one of them is well displayed, exhibiting in very good condition the surface-ornament. Were this plate unfolded, it would be about seven inches long and two and a half inches wide. Three or four inches of what seems to be the posterior portion lies flat upon the matrix, and shows the contour quite perfectly. The plate is apparently equally thin throughout; and the outer margin seems, judging from the portion that is displayed, to be pretty regularly arched, and the posterior margin to be rounded and sloped a little forwards towards the inner border.

Another bone, probably also a jugular, is worthy of notice. This appears to be an anterior plate; nearly one-half of it can be made out: it is symmetrical, having a stout angular midrib with two lateral wing-like expansions. When entire, it would be four and a half inches wide and one inch and three-quarters long. It is impossible to overlook the resemblance of this bone to the jugular plate of *Asterolepis*; and, like it, this probably fitted into the top of the arch formed by the junction of

* Poissons Fossiles du Vieux Grès Rouge, troisième livraison, p. 95, tab. 32. figs. 18, 19.

the mandibular rami. In *Rhizodus*, however, there appear to be two other plates, as we have already seen: these would lie, one on each side of the median line, immediately behind the anterior plate, which is very nearly as wide as the two others put together.

All these bones, as well as several other fragmentary specimens, have the surface covered more or less densely with strong vermicular sculpture composed of hollows and ridges; the latter in some become tubercular, but in others stream over the surface smoothly and regularly, with here and there an occasional bifurcation; in others, again, the vermicular grooves are intricately involved, and sometimes they are broken up to form circular pits. These are the dominant markings in the bones already before us; but the sculpturing on the surface of some opercular plates which we also assign to the same large fish, and which will presently be described, is somewhat modified. In these the vermicular ornament is less developed, and the pitted and tubercular predominate, the ridges being rough and much broken up.

It is on account of these peculiar surface-characters that we deem these bones to belong to *Rhizodus*; but this is not the only evidence. On the slab with the anterior jugular plate there is a portion of a scale of *Rhizodus*; and on that with the two large jugulars several scales of this fish are found lying in contact with them. If we are right in attributing these scales to *Rhizodus*, we have in the above facts strong corroborative evidence that these bones also belong to it.

The opercular plates above referred to are four in number: three are opercles, one is apparently a præoperculum. They are all crescentic in form, having their anterior margins well hollowed, and both extremities considerably produced. The largest operculum is six inches from point to point, and is upwards of two and a half inches wide; the posterior margin is a little sinuous, and is bordered with several parallel depressed lines, probably indicative of growth; the anterior margin is bounded by a wide, smooth, articular surface, which is divided from the rest of the operculum by a ridge. The præoperculum is similar in form to the operculum, but it is wider in proportion to its length, and there is a single groove following the sinuosities of the posterior border; the anterior margin is concave, with a very narrow articular surface.

Notes.—It is the intention in this and the following notes to comment on the value of the various genera and species recently proposed by Prof. Owen in his paper "On the Dental Characters of Genera and Species, chiefly of Fishes, from the

Low-Main Seam and Shales of Coal, Northumberland"*. It has become necessary to do this, as the anticipated beneficial results from the former "Criticism" of the "Abstract" of the paper as read have not been realized†, though the influence of this criticism is distinctly traceable in the text of the published paper, as well as in the appended footnotes.

The first genus we have to refer to is that named *Miogonodus* (pl. 8), which is founded on the section of a tooth that in no respect differs from that of the so-called *Rhizodus lanceiformis*, Newberry. We have shown in the former part of this communication that this reputed fish is most probably a Labyrinthodont amphibian; but be this as it may, we have teeth of this species attached to the dentary bone exactly similar in contour to, and not larger than, the figure of the tooth of this so-called new genus: and when a longitudinal section of these teeth is examined under the microscope, there is no perceptible difference in the minute structure from that of the tooth of *Miogonodus*; even the concentric layers of dentine, which are considered characteristic, are equally well marked. Certainly, when the tooth of *R. lanceiformis* is perfect, the base exhibits the Labyrinthodont infolding of the peripheral wall of dentine; but when the tooth is found detached (and that figured by Prof. Owen was so found), the basal portion is rarely if ever present; and then the dentinal walls are observed to thin out from the interior and to terminate below, when seen in section, in sharp wedge-shaped points, just as they are represented in the figure of *Miogonodus lanianus*. The tooth, then, on which this genus is founded is merely the upper portion or crown of a tooth of the so-called *Rhizodus lanceiformis*.

Rhizodopsis sauroides, sp., Williamson.

Several specimens of the elegant fish upon which Professor Huxley founds the genus *Rhizodopsis*‡ have occurred at Newsham. They are all in a very incomplete state, though, with the aid of the whole series, many of the characters can be determined. The most perfect specimens are between five and six inches in length; the largest is eight inches long, exclusive of the tail, which is wanting; and the smallest is not more than two or three inches in extent. There is proof, however, that this species sometimes attains a considerable size: a crushed head has been found that measures nearly three and a half inches in length; and ossified vertebral rings have occurred that are nine-tenths of an inch in diameter.

* Trans. Odontological Society, 1867.

† Geological Magazine, vol. iv. pp. 328 & 378.

‡ Quart. Journ. Geol. Soc. vol. xxii. p. 596 (1866).

In all respects our specimens agree well with Dr. Young's description of this species in the 'Journ. Geol. Soc.' (*loc. cit.*). The scales are usually well preserved; all the fins, as well as the tail, can be determined; and the gill-opercles, mandibles, and upper jaws, in a more or less entire state, with the teeth attached, are all displayed.

The scales vary, of course, greatly in size; on the smallest fish they cannot be more than a quarter of an inch long, while large detached scales measure an inch in length. They are all, however, so perfectly similar that it is impossible to deny their specific identity. The coarseness of the surface-sculpture and the thickness of the scale vary, as might be expected, with its size; but no other difference can be detected. It is therefore only left us to follow the prudent caution of Dr. Young, and to wait for further information before doing anything so rash as to divide specifically the thin and delicate from the thick and comparatively coarse scales. There is one character, however, which seems to have escaped the notice of this palæontologist, and which is pretty distinct in one or two of our examples. The dorsal and ventral fins are protected in front by a series of thick enamelled scales, which are brilliantly glossy and minutely punctured, not at all like the body-scales, but similar to those in front of the fins, in *Megalichthys*. The first or proximal scale is very stout, if not a solid cylinder, and is three-quarters of an inch long; it looks almost like the base of a spine, but is probably composed of two lateral plates. This is succeeded by a double longitudinal series of elongated rectangular pieces, which extend apparently almost to the distal margin of the fin.

The premaxillary bones, which were wanting in Dr. Young's specimens, are present in some of ours; and they, as well as the mandibles, have a large, slightly curved laniary tooth at the distal extremity. This is succeeded by a series of numerous small conical teeth, of the same size and character as those of the maxilla. These, as well as the small mandibular teeth, are placed at pretty regular intervals, though it is not uncommon to observe two or three pressed close together. Traces of two or three additional laniary teeth can be observed in the mandibles, situated on a line a little within the row of smaller teeth.

The premaxillary bone is unusually long; the maxilla is shorter than the former, and is narrow in front and expanded considerably behind. The mandibles are long, narrow bones, with the margins nearly parallel and the distal extremity rounded. The surface of all these bones is rugose, with irregular reticulated ridges or wrinkles and punctures.

All the bones of the jaws frequently occur detached. A large series of such have been procured, many of which are associated with the scales of the fish. The anterior laniary teeth are nearly always present in both the præmaxillæ and mandibles; but the additional large teeth of the latter are seldom present. In four or five instances, however, they are distinctly displayed; and in one specimen there are five laniary teeth, including the anterior one.

In the detached state the form of these bones can be well observed. The maxillaries are usually seven-tenths of an inch long and about three-tenths of an inch wide at the broadest part. They are flat thin bones, produced and pointed in front, and widened rather suddenly behind, as already stated; the alveolar border is nearly straight; the upper border in front is parallel with the alveolar border for some little distance backwards; it then suddenly ascends to the posterior margin, which slopes backwards and downwards. There is, at a little distance from the anterior extremity, a well-developed narrow articular process, which stretches upwards and forwards. The teeth vary somewhat in number; there are usually about twenty-five, which are arranged along the alveolar margin in regular order. This regularity, however, is frequently disturbed by the approximation of two or more; sometimes three or four are placed close together.

The præmaxillaries are long narrow bones, about as long as the maxillaries, being usually seven-tenths of an inch in length and nearly three-tenths of an inch broad; the alveolar margin is almost straight; the opposite margin gently slopes backwards in a somewhat sinuous course; so that the bone is pretty regularly wedge-shaped, the posterior extremity being pointed. There are about the same number of teeth as in the maxilla, with the addition of a large conical laniary tooth in front, immediately before which is a small tooth or two.

The mandibular bone we have never seen quite perfect: one of the most complete in the series measures one inch and four-tenths in length, and about two-tenths of an inch wide near the front; the upper and lower margins are nearly parallel; it is rounded in front, and appears to taper a little at the posterior extremity; the anterior extremity is slightly bent upwards. There are from fifteen to twenty teeth in our fragments; the number must be much greater in the entire ramus. There is likewise a large laniary tooth in front, and three or four others placed along the ramus, in a line within the small teeth; in front of the anterior laniary there is a small tooth or two like those in the præmaxilla. These, however, are not always to be seen; and the posterior laniary teeth are very

rarely present, or are perhaps frequently buried in the matrix. They are placed at some little distance from each other; and the small external teeth, like those of the upper jaw, frequently exhibit considerable irregularity, though on the whole they are placed apart at pretty regular intervals. The above description of the jaws applies to those of the usual size; but we have a mandibular bone which, if complete, would be upwards of three inches long, and a maxillary or two of corresponding dimensions.

The laniary teeth are grooved at the base; and here the peripheral dentine is a little infolded or plicated; and in fine specimens the surface of the crown exhibits a thin film of enamel. Traces of enamel, too, are occasionally found on the small teeth; but they are most frequently without it, probably in consequence of erosion.

One curious fact in connexion with the occurrence of this species is worth recording. Several of our specimens were found concealed within the stems of reed-like plants, which bear somewhat the appearance of calamites. A single individual occurred in each stem, nearly filling it. How they got into this position, whether accidentally or otherwise, it is impossible to form an opinion; but as, out of a score of individuals that have been found, four or five have been so placed, it would seem that something more than mere chance has had to do with it.

Note.—It is apparently on fragments of the jaw-bones and on the teeth of *Rhizodopsis sauroides* that Prof. Owen has founded his *Dittodus parallelus*, *Ganolodus Craggesii*, *Characodus confertus*, and the Batrachian genus *Gastrodus*. The figure of *Dittodus parallelus* (pl. 1) seems to us to represent nothing more than a fragment of either a mandible or maxilla of this fish, with a few pairs of the teeth in juxtaposition, the rest having been removed either before deposition or in making the section.

When two teeth grow up close together, as we have seen is not unfrequently the case in this species, the peripheral dentine of the two is often united at the base, and then we have a "twin-tooth" in all respects similar to those figured of this so-called *Dittodus*, and just as well entitled to be compared to the "Siamese twins." We have now before us numerous sections, many of which were made several years ago, demonstrating this fact; and in one or two instances there are even three or four teeth so united.

That which is denominated "osteo-dentine," in the apical part of the pulp-cavity, is, we apprehend, a mere film of the

inner layer of dentine. A similar substance occurs in many of our sections, exhibiting the general appearance and dotted structure given to it in Prof. Owen's figure; and this is undoubtedly the inner film of dentine; and the dots are the orifices of the calcigerous tubules. When the film is a little thicker, the dots become elongated; and in other specimens they gradually assume the regular tubular appearance, in accordance with the increased thickness of the section.

Ganolodus Craggesii is founded on a mandibular bone of the same fish. This fragment is a little distorted, and has the posterior extremity broken off and turned forwards; and all the laniary teeth, with the exception of the anterior one, are lost, as we have already seen is frequently the case in the mandibles of *Rhizodopsis*. The size, form, and surface-sculpture of the bone, which latter is well represented in the wood-cut, as well as the character, size, and arrangement of the teeth, all prove this.

There is no difference whatever between this mandibular ramus and several that are now before us of *Rhizodopsis*. *Ganolodus Craggesii*, Owen, will therefore have to give place to *Rhizodopsis sauroides*, sp., Williamson.

Ganolodus sicula (pl. 7) is very intimately related to a very different fish. The tooth on which this species is sought to be established is perhaps the commonest in the shales of the Low-Main seam; it belongs to *Megalichthys*, and is apparently a laniary tooth of a young specimen. There is not the slightest perceptible difference in the form and structure of the tooth, as represented in the figure of this so-called species, and the form and structure of the numerous sections of teeth of *Megalichthys* which we happen to possess. That the specimen figured was grooved and plicated at the base, like the tooth of this fish, is proved by the remnants of the plicæ, as may be seen on referring to fig. 1 b, pl. 7. Prof. Owen calls these fragments "part of the parietal dentine." Were this strictly correct, the calcigerous tubules would be seen cut across, producing the appearance of dots more or less elongated, as is well represented by Mr. T. West in pl. 14. fig. 4 (*Gastrodus*). On the contrary, the tubules in the fragments alluded to are all exhibited lengthwise, as they are in the cut edge of the peripheral dentine—proving to demonstration that these fragments are portions of the basal plicæ. To be satisfied of this, it is only necessary to examine a longitudinal section of the tooth of *Megalichthys* or any other tooth with a plicated base.

The variety *G. undatus* (pl. 7. fig. 7) is most assuredly the tooth of *Strepsodus sauroides*, Huxley: the double bend of the apex and general proportions of the crown put this beyond doubt.

A fragment of a maxillary bone of *Rhizodopsis* has, it is impossible to doubt, served for the establishment of the so-called *Characodus* (pl. 13). Here there is not one tooth left; they are all broken away; but the form of the fragment itself, tapering at one extremity and suddenly expanding at the other, as likewise the columnar structure of the bone for the support of the teeth, prove this to be an imperfect maxillary of *Rhizodopsis sauroides*. These peculiar pillars of bone supporting the teeth are very characteristic of the jaw-bones of this fish; but in the præmaxilla they are most developed. Some of our specimens (Pl. XVI. fig. 5) are precisely similar to that figured as *Characodus*, the teeth having been all broken away, with the exception of three or four. The display of this curious structure depends much on the plane of the sections; it is possible to cut it nearly all away, leaving merely the external layer of bone on one side; and it is never developed to the same extent in the præmaxilla and mandible.

The præmaxilla is the basis of the genus *Gastrodus* (pls. 14 & 15) the supposed Batrachian, as is evinced by the shape of the fragment, the size, form, character, and disposition of the teeth; nor is there any important difference in the minute structure of the teeth in this so-called genus. According to Prof. Owen's measurements, the dentinal tubules in *Dittodus parallelus* have a diameter of $\frac{1}{1000}$ of an inch, in *Characodus* $\frac{1}{1000}$ of an inch, and in *Gastrodus* $\frac{1}{1000}$; while in *Rhizodopsis* we have ascertained that they are likewise about $\frac{1}{1000}$ of an inch in diameter. The teeth of the so-called *Gastrodus* are certainly represented to be without enamel; but we have seen that it is frequently absent in *Rhizodopsis*; and many of the teeth, as exhibited in the figure, are cut diagonally short, so that their form and proportions are destroyed. The appearance thus presented is very common in sections of minute jaws, and, unless clearly understood, may readily lead to error. The diagonal section of a quill illustrates this very well.

The bone-cells of the jaw of *Rhizodopsis* are quite as Batrachian as are those figured of the pseudo-*Gastrodus*; and so are those of *Megalichthys* and many other sauroidal fishes.

There is, then, no evidence in the paper referred to of a minute air-breathing Batrachian of the age of the lower seams of the Northumberland coal-field, the so-called genus *Gastrodus* being resolvable into *Rhizodopsis sauroides*, a Ganoid fish.

Ctenodus cristatus.

Since the publication of the paper on *Ctenodus**, the matrix

* Ann. & Mag. Nat. Hist. Feb. 1868.

has been carefully removed from the upperside of the large sphenoid bone of this species by which the size of the fish was estimated. And now this interesting specimen reveals to us the cranial bones of the occipital region in an undisturbed and excellent state of preservation. The whole of the bones of one side are almost perfect; so that there is no difficulty in restoring this portion of the cranium, the constituent bones of which are arranged exactly as they are in the figure of the "cranial buckler" of *Dipterus* given by Hugh Miller in his 'Footprints of the Creator.'

The bones vary little in size, and, with the exception of the central occipital and parietals, are mostly irregularly pentagonal. There are three occipitals: the central one is not much larger than the lateral; the former is nearly as wide as it is long, and is seven-sided, with the anterior margin a little pointed in the centre, and the posterior margin nearly straight. The lateral occipitals are connected with the postero-lateral margins of the central occipital, and, diverging in front, admit a bone on each side, which is wedged in between them and the antero-lateral borders of the central occipital and the external margins of the parietals. External to these bones, and in connexion with their outer margins, are three other bones, which form the lateral borders of the cranium. In all there are five bones on each side of the central occipital and posterior part of the parietals. Only a small portion of the left parietal is preserved; but enough is present to show that this pair of bones are elongated, being widest apparently a little behind their centre, and having their posterior margins slightly divergent to receive the anterior angle of the central occipital.

The surface of the bones is not ornamented with "waved and bent lines," as those of *Dipterus* are described to be by Miller (*ibid.* p. 61), but is minutely granulated and punctate, similar to that of the opercles described in the paper on *Otenodus* already referred to, and here and there are indications of the radial bone-structure beneath.

The original estimate of the width of this head was nine inches. It is now evident that it really was eight and a half inches across the occipital region, without taking into account a fragmentary bone, probably a portion of an operculum. Were this added to the above measurement, the width would be ten inches.

The external characters of the palatal plates of the various species of *Otenodus* were described in the paper on that genus mentioned above. Nothing, however, was said of the internal structure, such matters of detail having been reserved for some future occasion. But it is now perhaps desirable to give some

account of the microscopical characters of these peculiar dental plates.

In sections made across the transverse ridges that cover the whole surface of the plates, a very beautiful structure is presented to view. The entire substance is found to be composed of a minute reticulation of bone-like matter, the meshes or medullary canals being large and much complicated. The ridges stand up from the surface in the form of conical tooth-like processes; and the reticulated matter of which they are composed is perfectly continuous with that of the plate or base; but the meshes or medullary canals in them are a little elongated, and the surface is protected by a compact, rather thin layer, which is only distinguishable from the rest of the tissue by its density and darkness of colour; on this layer there is a thin external coating of enamel.

At the base of the plate there is a stratum of considerable thickness in which the reticulation becomes somewhat closer, and which is characterized by numerous short elliptical bone-cells, the radiating canaliculi of which are frequently obliterated, but in well-preserved specimens they can be observed distinctly. The network of this stratum is continuous with that which lies immediately above it, but is at once distinguishable by its darker colour, greater density, and the presence of radiating cells. The substance forming the reticulation of the upper portion of the plate is, on the contrary, devoid of bone-cells, and is pale and transparent; but it is coated with a thin layer of a darker matter, in which are numerous branched tubules. When the section is made very thin, these tubules, however, all disappear, and the substance is then to all appearance perfectly homogeneous. These tubules are likewise very frequently invisible, even in comparatively thick sections, probably on account of the state of the fossil; or it may be that the canaliculi have all disappeared under the influence of the balsam used in mounting the specimens.

The peripheral enamel is very often wanting; and even the dense continuous layer of bone-like matter immediately beneath it is frequently entirely worn away; and then the section presents a rugged margin.

The microscopic structure of *Ctenodus* has been figured and described by M. Agassiz, in his '*Poissons Fossiles*' (vol. iii. p. 166, tab. M. f. 3). The figure is very good, so far as it is worked out; but when the author describes the "*cellules calcifères*" at the base of the plate as without ramifications, it is evident he has been deceived, probably by the use of balsam; or it is just as likely that the canaliculi had not been preserved in the specimen he examined. He is also wrong in

his assertion that "la substance qui forme la surface extérieure de la dent est parfaitement homogène, sans trace de structure quelconque." If his sections had been made very thin, this substance would undoubtedly have appeared so. The examination of many specimens is frequently necessary to correct errors of this nature.

Note.—It is on the palatal tooth or plate of *Ctenodus*, probably of *Ctenodus obliquus* (or, perhaps, *C. elegans*, or it may be on a minute plate of one of the larger species) that Prof. Owen has founded his genus *Saganodus* (pl. 12). This is one of the genera on which no remark was made in the "Criticism" of the "Abstract;" but a mere glance at the figure in the paper is sufficient to satisfy us that it represents nothing else than a small imperfect palatal plate of this genus. One of the authors of the present communication has had in his cabinet for many years numerous sections of the palatal plates of *C. obliquus*; and on comparing them with the figure of the "teeth and a small portion of the jaw" of the so-called *Saganodus*, no difference of the slightest importance can be perceived. The six wedge-shaped ridges seen in transverse section stand up from the bony network of the plate in the form of conical tooth-like processes, all inclined a little to one side, and increasing in size towards the same side, and having their reticulated substance continuous with that of the plate. In all these respects the resemblance to the figure is so great that no one can doubt for a moment that the so-called jaw and teeth of *Saganodus* are identical with the palatal tooth of one of the *Ctenodi*.

In the example figured by Prof. Owen, as also in many of our specimens, the external enamel and the peripheral walls of continuous matter have been worn away. His section is evidently a little diagonal, as proved by the increased depth of the plate ("jawbone"). And the minute structure, as rendered in fig. 3, is perfectly similar to that of many of our specimens.

In the so-called *Saganodus* we see a remarkable example of the danger of trusting entirely to sections of minute objects, the planes of which are not understood. The oral armature of *Ctenodus* we have seen is composed of plates having on the surface several transverse wedge-shaped ridges, which are usually denticulated or tuberculated. Had it been understood that the specimen examined was a section cutting such ridges transversely, it never could have been described as a fragment of a "jaw supporting conical teeth."

It has been already stated that the enamel is frequently

worn away. It is, however, generally persistent towards the outer margin of the plate; a little further back it is almost invariably removed; and still further back, on the older portion of the plate, the peripheral wall of hard matter is scarcely ever found, having undoubtedly been worn down by the action of the jaws. It is therefore clear enough that, in accordance with the line of the section, we might have the margins of the tooth-like processes rough, without any distinct peripheral wall, as in the figure of the so-called teeth of *Saganodus*; or there might be such a wall, without any external enamel; or, again, both the enamel and peripheral wall might be present: and such a series of sections of *Ctenodus* we possess. Were we, then, ignorant that the sections were made from different parts of the same object, we might readily be led to erect three distinct genera on the palatal plate of a single species of *Ctenodus*. And, again, were we disposed to create species, various degrees in the obliquity of the section would afford excellent opportunities for so doing, as the tooth-like processes would vary in length and form in each section.

Palæoniscus Egertoni, Agassiz.

Two large patches of scales, representing the greater portion of the fish, have occurred at Newsham. The scales are in a very good state, and show the characteristic markings of this very pretty species; when examined with the microscope, it is perceived that the surface of enamel is regularly covered with extremely minute punctures or dots. The larger patch is one inch and five-eighths long, and upwards of three-eighths of an inch wide. The fins are not displayed; neither are there any traces of head or tail.

Several other *Palæonisci* have been found in our shales, as well as one or two species of *Amblypterus*. There is also in the collection a specimen or two of what we take to be a species of *Eurylepis*, Newberry. Though these are not in a very perfect condition, they are in a much better state of preservation than the specimens of *P. Egertoni*. In many of them the head is present; and both the tail and fins are frequently determinable. Several of them are probably new; but at present we cannot enter more fully on this branch of the subject, and must leave it for some future opportunity. A few words, however, may be said on the dentition of these fishes, particularly as it seems to be little understood; indeed it appears that little or no attention has been given to this matter.

M. Agassiz, in his great work, '*Poissons Fossiles*,' states that the teeth of *Palæoniscus* are "en brosse" (tome ii. pt. 1. p. 42); but the words which immediately precede this expression

must be taken to qualify it. They are,—“Mais les dents sont si excessivement petites qu'il est très-rare de pouvoir les distinguer.” From this it is pretty evident that this distinguished naturalist knew very little about the matter. Succeeding writers, however, appear to have rested satisfied with this description. Mr. Binney, indeed, so long ago as 1841* figured the jaw of *Palæoniscus Egertoni*, showing a row of large, conical, sharp-pointed teeth, as well as a few of the small external ones. He says that the jaw is “armed with sharp conical teeth of a nearly uniform size, inclining from the front.” This communication, however, has been unfortunately overlooked.

The teeth of these jaws are not “en brosse,” neither are they of that feeble “villiform” structure so much insisted on of late. They are disposed in two distinct rows, one within the other, much in the same fashion as in *Megalichthys* and *Rhizodopsis*, but still much more like that which obtains in *Pygopterus*, in which the teeth are likewise arranged in two rows—one being of large laniary teeth, the other of small external ones. And, according to M. Agassiz, they do not in this genus form “une brosse ou râpe comme les dents du *Polysterus*.” The inner row in *Palæoniscus* (Pl. XV. figs. 3, 4, 5) is composed of a few comparatively large, curved, sharp-pointed conical teeth, which are placed at some little distance apart from each other. In the outer row the teeth are numerous, small, conical, and pointed, occasionally crowded, and in some species apparently not quite in regular order.

It is this outer row of comparatively small teeth that appears to have been seen and described by M. Agassiz, the inner row of laniary teeth having escaped his observation. Nor is it any wonder that such a matter of detail should have been overlooked by this naturalist; and, indeed, many such omissions are found in the great work alluded to. But when we consider the novelty and vastness of the matter before him, and especially that the bent of his mind was directed mainly to the larger problems of his subject, the only marvel is that such blunders are not more numerous. The laniary teeth are very frequently concealed in the matrix; and when the jaw is in its natural position, they are liable to be obscured by the external row, which stands up on an elevated ridge of the alveolar margin.

The laniary teeth vary in number in the different species, and probably, in a limited degree, even in the same species: but this is difficult to determine; for it rarely happens that the

* Trans. Manchester Geol. Soc. vol. i. p. 167, pl. 5. fig. 12 (1841).

row is complete, these large teeth being frequently broken off. Nevertheless in several of our specimens they can be observed arranged at pretty regular intervals, evincing that the series, as far as it extends, is complete. In one mandible, in which the row is nearly entire, there are eighteen or nineteen teeth; and in the mandible of another species fourteen or fifteen can be counted. The teeth in the maxillæ appear to be equally numerous.

The teeth themselves (Pl. XVI. figs. 1 & 2) are, as we have already said, sharp-pointed and conical; they are a little recurved, the bend being usually greatest a short way above the base. Fine large specimens are upwards of one-eighth of an inch long; but they are generally much less; they vary considerably in this respect in the different species. They are most frequently wide at the base, and contract rather suddenly immediately above; thence the attenuation is very gradual, until within a short distance of the apex, a little below which the crown is slightly swelled; from this point the sides of the tip incline more rapidly towards each other, and unite to form an extremely sharp apex. In some species the apex is much produced and attenuated, in others it is comparatively short; but in all it is characterized by its sharpness. The sharp-pointed tip or apex is formed of a thick cap of enamel, and is usually quite smooth and highly polished. Below the cap, in all the species examined, the crown has a subdued lustre, and is fretted in a very beautiful manner with numerous minute, short, close-set, longitudinal depressions, which, being arranged lengthwise, have occasionally a lateral inclination: hence the peculiar fretted appearance of the surface.

On making a longitudinal section (Pl. XVI. fig. 2), the pulp-cavity is seen to conform to the shape of the crown; the cavity is wide below and narrow above, tapering gradually towards the apex, and terminating just within the extremity of the dentine. The tip of enamel fits on to the top of the dentine like a ferrule, and is in the form of an inverted V, with the angle filled up for some distance, and the stout limbs turned out a little below and mortised, as it were, into the dentine. The enamel-cap varies a little in form in the different species; but it varies still more in accordance with the plane of the section. When the section is made directly through the centre, the solid apical portion of the enamel is seen to be much produced, and very sharp. By making the section a little eccentric, the solid tip is reduced in length and sharpness; and by carrying the process a little further, the enamel-cap becomes a mere thin covering, like a transverse section of

a low-pitched roof; and at last it entirely disappears, and is replaced, as it were, by a somewhat obtuse point of dentine.

In the finest specimens, the whole tooth below the enamel-cap is coated with a distinct film of enamel, which is perfectly colourless; in others traces of it are observed only here and there; but in by far the greater number it is entirely wanting: when this is the case, the surface of the tooth is frequently observed to be roughened, as if by erosion. And it may be here stated that it is not merely the enamel that is eroded, but it frequently occurs that in the teeth of *Palæoniscus*, as well as in the teeth of other small fishes, the dentine itself is worn away to such an extent that very little of it is left to protect the pulp-cavity. It is, therefore, not unlikely that all the teeth of *Palæoniscus* were originally coated with enamel; or it may be that in some species there is an external coating of enamel, and in others it is wanting. When the tooth is perfect, its walls are thick in proportion to the calibre of the pulp-cavity; the calcigerous tubes are very fine and numerous.

Note.—After the above description of the tooth of *Palæoniscus*, it is scarcely necessary to say that there is no character by which it can be distinguished from that of the so-called genus *Ganacrodus* of Professor Owen (pl. 6): the teeth of the latter and former agree in size, form, and structure. We have found the enamel-tip to exist in *P. comtus* and other species from the marl-slate as well as in the species from our Coal-measures. This we have proved in the most satisfactory manner, not by taking the teeth at random as they are scattered through the matrix, but by taking the jaws from the heads of well-authenticated *Palæonisci*, and examining the teeth both externally and in section. After having done this in a great number of specimens, we are enabled to state that the small enamel-tipped teeth found detached in the Cramlington and Newsham shales are exactly the same as those attached to the jaws. They are of the same size and form, with the same bright tip of enamel and finely fretted walls; and in section there is no difference whatever; the general form, the enamel-cap, the pulp-cavity, and dentine are all precisely the same; and all precisely agree with the tooth of the so-called *Ganacrodus*. It is therefore hard to understand what is meant by the use of such terms as “the villiform teeth of *Amblypterus* and *Palæoniscus*,” “the vague and ill-defined characters of those *en brosse* of *Palæoniscus* and *Amblypterus*.” Such expressions may indeed mislead, as they or similar words appear to have misled their author; *Ann. & Mag. N. Hist. Ser. 4. Vol. i.* 26

but they can never for a moment obscure the light derived from a thorough examination of the facts.

The laniary teeth of *Palæoniscus* and *Amblypterus* agree in all essential characters; and the tooth of the former is in every respect similar to that of Prof. Owen's "new genus." Consequently this genus can never be adopted by palæontologists.

With regard to the coating of enamel on the crown of the tooth, on which much stress is attempted to be laid, we can only say, in addition to what has been previously stated, that it is most frequently absent from teeth attached to the jaws, and that by far the greater number of our specimens are deprived of it, (as we are inclined to believe) from the effect of erosion. Be this, however, as it may, the fact remains unchanged. Authenticated *Palæoniscus*-teeth in connexion with the jaws agree in all respects with the tooth of *Ganacrodus*, even to the absence of enamel on the crown of the tooth.

Palæoniscus, however, is not the only genus in which this beautiful enamel-cap exists. Although Prof. Owen is pleased to ignore what is stated in the previous "Criticism" on the subject, we here venture to assert that the teeth of *Pygopterus*, *Amblypterus*, *Gyrolepis*, and *Cycloptychius* have a perfectly similar tip of enamel. This we have determined by our own independent research, and can prove the fact by numerous sections of the teeth of all these genera.

Considerable importance, however, appears to be attached to the supposed novelty of this peculiar tooth-structure in the paper so often referred to. Prof. Owen therein states, on this subject, "that he had not before met with any similar tooth in the whole range of his odontological researches"*. Between twenty and thirty years ago, however, M. Agassiz described and figured the very same structure in the teeth of *Pygopterus* †, *Saurichthys* ‡, *Polypterus*, and *Lepidosteus* §, the last two being recent sauroid fishes.

After giving a full description of the general characters of the tooth of *Pygopterus*, M. Agassiz says, "Un cône de dentine entoure cette cavité-pulpaire de tous côtés; il est plus massif au milieu, là où se voit le renflement extérieur, plus mince vers la base et vers le sommet, et recouvert en haut d'un capuchon en émail, qui occupe à-peu-près le tiers de la dent et forme à lui-seul toute la pointe. En examinant

* Pamphlet reprinted from the 'Trans. of the Odontological Society,' p. 29.

† Poiss. Foss. vol. ii. pt. 2. p. 152.

‡ Ibid. vol. ii. pt. 2. p. 153; tab. H. figs. 2-5.

§ Ibid. vol. ii. pt. 2. pp. 27 and 43, tab. G. figs. 9-12.

la dent à la loupe, on reconnaît au plus fort du renflement extérieur une ligne circulaire qui indique la limite du capuchon émaillé et de la dentine. La dentine elle-même n'offre rien de remarquable. Les tubes calcifères Ceux du sommet se continuent, comme chez le *Polypterus*, dans l'émail, où ils paraissent plus roides, mais en même temps plus fins et moins régulièrement disposés que dans la dentine."

Of *Polypterus* the same author writes as follows:—" Cette dentine forme la plus grande partie de la dent; elle n'est recouverte qu'au sommet par un petit capuchon d'émail très-dur, et dans lequel je n'ai pu reconnaître ces fibres composées de petits cubes superposés, telles qu'on les a reconnues chez les mammifères. L'émail du *Polypterus* (fig. 12) est transparent comme du cristal, sans trace de structure, et ce n'est que dans sa base que pénétrèrent les dernières extrémités effilées des canaux calcifères de la dentine," etc.

Respecting *Saurichthys* it is stated:—" Cette différence entre le socle et le sommet est encore plus frappante, lorsqu'on examine leur structure au microscope; le premier est composé de dentine, le dernier d'émail. La cavité pulpaire est un cône creux entouré d'un cône de dentine massive, sur lequel repose le capuchon émaillé comme dans les dents du *Polyptère*." This description of the structure of the tooth of *Saurichthys* is very different from that given in the 'Odontography' (page 170), where the cap of enamel is certainly described, but not recognized as such, the author apparently not being aware of the difference between the base and the summit, pointed out by M. Agassiz. And indeed the description seems to be confined to the enamelled or upper portion alone, the basal portion evidently having been deficient in the specimen examined.

Similar passages might be quoted respecting *Lepidosteus*; but perhaps enough has been said on the supposed recent discovery of the "enamel-tipped spear teeth." We have seen that M. Agassiz fully described and accurately figured this form of tooth in four genera (Pl. XVI. figs. 3, 4) between twenty and thirty years ago (1833-1844); and we have determined its existence in four other genera, and have likewise verified the accuracy of M. Agassiz's observations in *Pygopterus*, *Lepidosteus*, and *Saurichthys*, making in all eight in which a cap of enamel is found. It is therefore highly probable that, when the subject is fully investigated, enamel-tipped teeth may prove to be not at all uncommon. But how has all this escaped the observation of the learned author of the 'Odontography'? for escaped him it assuredly has, or he

never could have written as he has recently done respecting *Palæoniscus*, *Amblypterus*, *Pygopterus*, *Polypterus*, and *Leptodosteus*.

Acanthodopsis Wardi, sp., Egerton.

For some time past one of the authors of this paper has had in his collection several jaws of a fish with large triangular teeth, five or six in number, and appearing like processes of the bone; and of so peculiar a character are they that it was impossible to say even to what family of fishes they belonged. It was not until similar specimens were found associated with other remains, that any light could be obtained respecting them. At length a crushed head or two were procured exhibiting the same peculiar jaws with the like curious teeth attached, lying in juxtaposition with the spines of one of the *Acanthodei*, partially buried in what appeared to be the broken-up skin of the fish, crowded with minute rhomboidal scales. In one specimen the two pectoral spines are placed in their proper position behind the head, and united to it by the continuity of tissue, so as to leave no doubt that they and the head belonged to the same fish. The uniting tissue, too, was mainly composed of granule-like scales of a lozenge-form. A tail likewise of an Acanthodian has occurred in the same locality, the scales on which agree both in size and character with those found with the heads. It is therefore quite certain that the jaws alluded to belong to the *Acanthodei*, notwithstanding the abnormal character of the teeth, which in this family are usually described as minute and conical.

In the genus *Acanthodes*, indeed, the teeth appear to have been determined only in one species, though M. Agassiz states, in his description of the genus, that fine teeth disposed in a simple range appear to garnish the circumference of the mouth*. The species in which the teeth have been determined is *A. pusillus*; and of this the same author writes that the mouth is "garnie de très-petites dents qui, même sous une très-forte loupe, ne paraissent que comme des petits points noirs"†. This is so definite that it is impossible to doubt its accuracy; we are therefore forced to the conclusion that in this genus, as at present understood, there are two very distinct kinds of dentition, so distinct, indeed, that it seems necessary to establish a new genus for the reception of those species which, like *A. Wardi*, may have large triangular teeth, similar to those alluded to. We therefore propose the generic appellation of *Acanthodopsis* for those *Acanthodei* with this peculiar dentition.

* Poissons Fossiles du Vieux Grès Rouge, première livraison, p. 39.

† Ibid. p. 36.

The remains in our possession of such fishes are divisible into two species by the characters of the spines, scales, and teeth. One of these is very much larger than the other. It is the smaller of the two that appears to be identical with *A. Wardi*. The larger species is probably the same as that of which Sir P. Egerton had obtained the head and anterior parts, and which is supposed by him to "have measured two feet six inches in length"*. A pectoral spine of this is stated to have been three and a half inches long.

The mandibular ramus of *A. Wardi* (Pl. XV. fig. 6) is about one inch and a half long and a quarter of an inch wide at the broadest part, which is near the proximal extremity, whence it tapers gradually to the distal end, which is rounded; the proximal end turns upwards, and presents a well-defined concave articular surface. The dentigerous bone is very thin, and its walls are usually pressed close together; the outer wall is irregularly striated longitudinally, the inner wall is smooth; the lower margin is strengthened by a stout styliform process, *c*, which is very liable to detach itself, when it assumes the appearance of a cylindrical spine graduating to a point in front; it is united behind to the articular process, and is probably nothing more than a prolongation of the angular bone.

This styliform process has been described as the entire mandibular ramus in some of the *Acanthodei*, and is seen occasionally attached to the head,—the dentigerous bone, with the teeth, having been detached. In Sir P. Egerton's figure of *A. Wardi* these styliform bones, so denuded, are seen still articulated to the head and thrown backwards. The teeth are frequently found attached to the thin-walled dentigerous bone, the styliform process having probably been left so attached to the head.

The teeth are never found separated from the bone. There are five or six in each ramus, two of the larger being in the centre, the smaller ones in front and behind; they are compressed in the direction of the jaw, and when seen in this position they have the shape of as many equilateral triangles with the lateral margins a little hollowed towards the apices, which are recurved; they are expanded at the base, where they become confluent, and are coarsely and irregularly striated from one extremity to the other; and the surface being liable to erosion, the striation is frequently exaggerated.

The upper jaw is coextensive with the mandible, and is apparently formed of one piece. The teeth are like those of the under jaw, and lock very accurately into them; they are of

* Quart. Journ. Geol. Soc. vol. xxii. p. 470.

the same size and character, and are equal in number to those of the mandible. The largest teeth are nearly one-sixth of an inch in length; they are much wider than they are thick from back to front.

On making a longitudinal section of the teeth in the direction of the jaw, the structure is found to be very peculiar. The jaw itself is composed of very dense bone on the surface, in which the Haversian canals are well defined, and the radiating cells are very numerous and minute; they are elongated-fusiform, with the canaliculi (when observable) sufficiently abundant and arranged for the most part at right angles to the long axis of the cells. In the superficial and denser portions of the tissue the cells and tubules are the most minute; in the deeper portions they are larger and less regular in form, and the bone becomes riddled with medullary cavities, until at length it is entirely reduced to a sort of cellular structure. This curious cellular tissue is continued into the teeth, and forms their central mass, there being apparently no distinct pulp-cavity, or, if any, it is confined to the base. This tissue becomes less open as it approaches, and gradually forms a dense layer at the surface of the teeth, in which layer the Haversian canals are as distinct as they are in the bone of the ramus, and the cells, diminished in size, assume their regular elongated form, and at the extreme margin they disappear. This peripheral layer, which represents the dentinal wall of ordinary teeth, is found to be continuous from tooth to tooth; it differs, however, in no respect from the dense external surface of the ramus. Indeed it is quite evident that the bone of the jaw is continued into and forms the teeth; they may therefore be looked upon as processes of the jaw. We have failed to detect the least trace of enamel on the surface of the teeth.

A considerable portion of one of the pectoral spines lies near to the crushed head of this species, in which the jaws are distinctly displayed with the teeth interlocked. The spine has lost its distal extremity; the fragment, however, is flattened towards this end; at the basal extremity it is thickened, and assumes a triangular form; a groove extends along the anterior margin. Detached spines have also occurred, agreeing exactly with Sir P. Egerton's description of the pectoral spine of this species.

The scales are minute rhombs, with the upper surface smooth and slightly convex. Some appear to be minutely and irregularly granulated. Perfectly similar scales clothe the heterocercal tail which was procured at Newsham, and which we believe to belong to this fish. It is about three-

quarters of an inch wide, and, including the pedicle to which it is attached, it is one inch and three-quarters long; the under lobe is not much produced, and the upper is rather obtuse; no rays are perceptible. The scales are well preserved, and are in an undisturbed state. Some of them are brilliantly glossy, and have towards the posterior angle a boss-like swelling; others are dull and minutely granular. Which is the true natural surface it is difficult to say, though it seems probable that the latter is. Be this as it may, both kinds of scales are found scattered in the vicinity of the head and spine.

Acanthodopsis Egertoni, n. sp.

A crushed head with the pectoral spines attached, a detached jaw or two, a few separate spines, and some scattered scales are all the remains that have occurred of the large species alluded to. The head, which could not have been less than two and one-quarter inches long, has one of the mandibular rami well displayed, with the teeth attached; but they are, unfortunately, in a very imperfect state. The ramus is very similar in character to that of *A. Wardi*; but the dentigerous bone does not appear to be striated; the styliform process is not much arcuated at the proximal extremity, and tapers gradually to the anterior point. The teeth are arranged in the same manner as in the smaller species—that is, with the larger in the centre and smaller at the extremities of the jaw; with the aid of a detached mandible we are able to ascertain that there are seven or eight in each ramus; they are not nearly so wide at the base as in the previous species, and they are more regularly and finely striated. Some of the bones of the head are finely and regularly tuberculated; these are probably the orbital plates. The similar plates of the other species appear to be irregularly granular.

The spines attached to the head are upwards of two and a half inches long, though they are not entire; but the largest detached specimen in our possession is quite an inch longer, though in it, too, the point is broken. This must have been longer than the largest mentioned by Sir P. Egerton; it is upwards of one-quarter of an inch broad, and is flat and curved like the others, resembling the blade of a scimitar; towards the base the inner margin is thickened and angulated, and a depressed line or groove extends from end to end a little within the anterior or arched margin; a few fine longitudinal lines are seen near to and almost parallel with the opposite margin; the point appears to be rounded, but is not quite perfect in any of our specimens.

The scales which are found associated with the head and

spines are very similar to, but they seem to be smaller than, those of the other species, as pointed out by Sir P. Egerton; they also appear to have the surface more elevated and rounded.

From the character of the scales and great size of the pectoral spines, but more particularly from the difference observed in the teeth, we consider ourselves justified in dividing this from the *A. Wardi*, and beg to dedicate it to Sir P. Egerton, who was the first to point out the probability of its specific distinctness. We therefore propose for it the name of *Acanthodopsis Egertoni*.

Gyracanthus tuberculatus, Agassiz.

The gigantic spines of this little-understood fish occur pretty frequently at Newsham and Cramlington in a fine state of preservation. In conjunction with Mr. J. W. Kirkby, one of the authors of this paper pointed out in 1863 that these spines were not, as usually thought, dorsal, but were paired spines, most probably pectoral*. We have now before us seventy-one of these formidable weapons; and the first thing that strikes the observer is, that by far the greater number have lost the apical extremity, and that they are not merely bent from front to back, but are also laterally curved. On closer examination it is found that there are as many bent to the right as to the left side, and that of such bent spines there are just twenty-four pairs. Thus twenty-three spines are left unaccounted for; these may be considered straight, being bent only from front to back, and their points are entire. But first respecting the paired spines: we have said that they have all lost their points; they are not fractured, however, but are all worn smoothly down diagonally at a very acute angle; and, what is still more interesting, this wearing always takes place at the side opposite to that of attachment. Assuming, therefore, that these spines are pectoral, and that they were inclined backwards and downwards, as assuredly they would be, then the wearing of the points is exactly such as would take place on their coming in contact with the ground. And, again, the largest or oldest spines are uniformly the most worn; some, indeed, are reduced to mere stumps. In one such specimen now before us, which is seven inches in circumference, and which must have been one of the very largest, only ten and a half inches are left. Another example, six inches in circum-

* See paper entitled "Fish-Remains in the Coal-measures of Durham and Northumberland," by Messrs. T. Atthey and J. W. Kirkby, read in the Geological Section at the Newcastle Meeting of the British Association.

ference, is only seven inches long, including the portion buried beneath the skin.

All this seems to demonstrate, beyond doubt, that these are really paired spines, most probably pectoral; and from this wearing we may fairly assume that *Gyracanthus* was a ground-fish, and that the spines assisted its motions at the bottom of the water.

The straight spines, or those which are not laterally bent, are all regularly arched from before backwards; and their distal or pointed extremities are all perfect, not being in the least degree worn. These are apparently dorsal spines; and that there is only one of such in each fish seems probable from the fact that they occur in the ratio of one to two of the paired spines, as shown by our previous division of the seventy-one specimens.

The dorsal spines are considerably smaller than the paired ones; they are more compressed, and the posterior denticulated keel is more strongly developed; the extreme point is smooth, compressed, and rounded in front. The largest are about eleven inches long, and three and one-quarter inches in circumference at the thickest part. The paired spines are fifteen or sixteen inches in length, and upwards of six and a half inches in circumference.

One or two specimens of the species denominated *G. formosus* have likewise occurred; and as the same spine of *G. tuberculatus* is occasionally found with both tuberculated and smooth ridges, the former can scarcely be considered a good species. M. Agassiz's figure of *G. formosus**, like *G. tuberculatus*, is laterally bent.

Large flat triangular bones are frequently found associated with the spines, measuring sometimes eight and a half inches long and six and a half inches broad at the widest part. Their structure is very open; and as they are seldom well preserved, they are probably only imperfectly ossified; the bone-fibre radiates from the apex to the expanded base. There can be little doubt that these are carpal bones, similar to those in connexion with the pectoral fins in the Sharks and Dogfishes. This bone is thickest at the apex, which is rounded, and thins out towards the distal expanded margin or base. The large longitudinal groove at the root of the spine probably corresponds to the lower or anterior margin of this bone; or it may be that it was fitted to a lower carpal which was coadjusted to this bone but, being entirely cartilaginous, has disappeared. However this may be, it can scarcely be doubted that this

* Poissons Fossiles, vol. iii. tab. 5. figs. 4, 5, 6.

triangular bone supported, directly or indirectly, the great pectoral spines.

There are found also frequently associated with the remains of *Gyracanthus* large thin layers or patches of matter, almost entirely composed of minute compressed bodies, of which there are two kinds. One, much smaller than the other, and by far the more numerous, is upwards of one-twentieth of an inch high and not quite so broad; it has usually two, sometimes three, conical, recurved, diverging points rising from an expanded base. The large kind is usually one-tenth of an inch high, and is somewhat wider at the base; it is sometimes a little larger, but more frequently much smaller. It is much compressed, and the base is considerably widened; the upper margin is divided into from four to seven much recurved conical denticles, which are sharp-pointed, and have four or five stout longitudinal ridges on the arched or dorsal surface. Several large patches of these bodies have occurred, one of which measures twenty inches by fifteen inches. It is therefore pretty clear that they cannot be teeth, which are not usually found together in such vast multitudes; they are much more likely to be dermal tubercles, and these patches to be the remains of the skin of *Gyracanthus*. It should also be mentioned that *Cladodus mirabilis* has occurred three or four times at Newsham, and always associated with these dermal patches. May it not, therefore, prove to be the tooth of *Gyracanthus*?

Note.—*Mitrodus quadricornis* of Prof. Owen (pl. 3) is undoubtedly nothing more than the larger kind of these dermal tubercles. In size, proportion, and form it agrees exactly with them; and in the minute structure there is no difference whatever, as is demonstrated by the numerous sections of them which we have had the advantage of examining. This "minnow," then, of our shales is found to be identical with *Gyracanthus tuberculatus*, perhaps the largest fish of the coal-measures.

In the figure of *Mitrodus* only a small portion of the denticles is shown; the points, being strongly recurved, are necessarily cut away in such a section as that represented. It is only the base of the toothlets that Prof. Owen has seen; and consequently his knowledge of the true form must be very imperfect. The angles represented at the margin of the denticles indicate the external ridges described above.

Diplodus gibbosus, Agassiz.

This is a common fossil at Newsham and Cramlington, and is usually found in connexion with a thick granular layer of

a substance resembling shagreen, large patches of which frequently occur studded all over with it. One such patch has been obtained which measured fifteen inches long and about seven inches wide. On this the *Diplodi* are comparatively few in number, and are scattered about. But in another patch, of which there are fifty-six square inches, they are very numerous, and are crowded together without order.

There can be little doubt that these shagreen-like patches are the remains of the skin of some large fish, and that the *Diplodi* are dermal tubercles in connexion with it, analogous to the spinous tubercles of the Rays. At the same time it must be admitted that it is possible enough that the larger specimens may have clothed the lips or jaws with a spinous pavement resembling in arrangement the oral armature of the Rays or Cestracions; or they may have ranged along the back or sides of the body in serial order, as the dermal spines frequently do in the Rays; or perhaps they may have been scattered here and there among the smaller ones, as is not unfrequently the case with such tubercles.

Diplodus has usually three recurved spines, two being large, the third quite small; they stand up from a common, rather deep, rounded or oval base. The two large or lateral spines are ranged side by side; they are stout, conical, and divergent, both being curved from before backwards, and a little compressed in the same direction. The small spine is similar in form, and is placed immediately behind the large ones, at their basal junction; and in front of them, in a similar position, there is a large, rounded, depressed tubercle. All the spines are strongly carinated at the sides from the apex to the base; and in well-developed specimens there are two other ridges, one in front, the other behind, extending downwards for some distance from the apex.

These are the normal characters of *Diplodus*; but it is very variable in form. The spines are not unfrequently found stiff and short, and much bent and divergent; on the other hand, they often occur much elongated, almost parallel, and comparatively slender. The number of spines also varies; sometimes there are only two, sometimes only one. When the latter is the case, the specimen is usually exposed in profile, and the long heel-like projection is well displayed; when, however, a complete tubercle is buried in the matrix with only one of the lateral spines and its base exposed, the appearance is much the same. A tubercle so seen is represented by M. Agassiz in 'Poissons Fossiles,' vol. iii. tab. 22 b. fig. 5.

If *Diplodus* differs much in form, it also varies greatly in

size. The largest are three-quarters of an inch from the base to the apex of the large or lateral spines; the smallest, measured in the same way, are not more than one-twelfth of an inch in extent. Between the two extremes, tubercles of every size occur. Now the smaller individuals, which are by far the most numerous, agree very well with *Diplodus minutus* of Agassiz, so far as the imperfect specimens described and figured by that author permit a comparison. M. Agassiz says he was not able to discern the median cone; but this is not to be wondered at, for none of his figures represents the base entire.

Note.—*Dittodus divergens*, *Aganodus apicalis*, *Aganodus undatus*, *Pternodus productus*, and *Ochlodus crassus*, described in the paper "On the new Coal Fishlets," are all referable to *Diplodus*. The genus *Dittodus* is established on two very dissimilar fossils: *D. parallelus* is, we have already seen, founded on the fragment of a jaw with a few of the teeth of *Rhizodopsis sauroides*; *Dittodus divergens* (pl. 2) is apparently nothing more than *Diplodus minutus* * of Agassiz; and, like his figure, that given by Prof. Owen is represented without the small central spine: indeed it is scarcely possible to show it in such a section as that figured in plate 2. The size, form, and histological characters all agree with those of our sections of the minute specimens of *Diplodus*.

Pternodus productus (pl. 10) is the single-spined variety of *Diplodus gibbosus* seen in profile, with a well-produced base; or it may possibly be a lateral section of a fully developed specimen in which one of the large spines only is exhibited. In either case the same appearance would be presented of the large projecting "heel," with its outline sweeping into the curve of the spine; and, in fact, the form, proportions, and size all exactly agree with those of similar sections in our possession of the single-spined variety of *Diplodus*. The minute structure is precisely the same; the greater portion, however, of the basal marginal boundary, from *m* to *b* in fig. 1, pl. 10, has been ground away; and that which is designated "osseous tissue of jaw" is merely a portion of the osteodentine of the pulp-cavity.

There are two species of *Aganodus* described: one, *A. apicalis* (pl. 9), is based apparently on a section made from before backwards of a single straight spine of the small variety of *Diplodus*. The two processes (*o*) below the spine are projecting portions of the base, the most of the base itself having been broken away. The opening between the two processes

* Poissons Fossiles, vol. iii. p. 205, tab. 22. f. 6-8.

is in part a natural cavity, frequently seen in sections. *A. undatus* (pl. 10) is a lateral section of a single minute spine of the same variety of *Diplodus*, somewhat abnormal in form. There is no difference of importance in the minute structure, and it exhibits in a most distinct manner the numerous concentric layers of dentine mentioned by M. Agassiz as characteristic of *Diplodus* (vol. iii. p. 209).

Diplodus has supplied Prof. Owen with still another generic form, which is the fourth based upon this variable fossil. *Ochlodus* (pl. 5) is nothing more than one of the large varieties of this dermal tubercle, crushed laterally—a variety, probably, having originally one of the large spines smaller than the other. A figure of such a tubercle is given by Mr. Binney in the paper before quoted*. From the representation of *Ochlodus* it is evident that the specimen has been crushed: the dentinal walls are cracked in several places, the upper wall has been forced in upon the osteo-dentine of the pulp-cavity, and the continuity of the tissue of the spines has been severed; the osteo-dentine of the pulp-cavity has, in a great measure, been displaced, and the base shattered to fragments. All these appearances are shown in a section now before us, which was made of a specimen crushed laterally or a little diagonally, and which closely resembles in size and contour *Ochlodus*. It is evident, too, that much of the fractured base in this genus, and also a considerable portion of the two smaller spines, have been removed in making the section.

The thickness of the dentine and the size of the pulp-cavity are very variable features in *Diplodus*. Even in the same specimen the peripheral dentine occasionally varies considerably at different parts of the circumference, as may be seen on making a transverse section of the spines; and as they are compressed, as we have stated above, the relative size of the pulp-cavity varies with the plane of the section. This is one source of variation; but were the pulp-cavity quite cylindrical, or rather circular in transverse section, its apparent relative proportion to the dentinal wall would depend upon the degree of eccentricity of the section. The pulp-cavity is consequently found to vary extremely in size in *Diplodus*. In the crushed specimen we have spoken of, this cavity is quite as large as it is represented in the figure of *Ochlodus*; and, again, in other specimens it is no larger than we see it in the figure of the so-called *Pternodus productus*.

The acute points represented in the section of *Ochlodus* are not the apices of the spines as believed by Prof. Owen; the true apices have all been removed in making the section

* Trans. of the Manchester Geol. Soc. vol. i. pl. 5. fig. 17.

These sharp prolongations are merely the ridges or keels described above as extending from the apices downwards, seen still projecting after their base (the dental support) has been removed. The same appearance is presented at the apex of the figure of *Aganodus undatus*, and strengthens our opinion of the nature of that form.

At the point of the largest spine of *Ochlodus* there is evidence of two of those ridges or keels, one probably being a lateral ridge, the other apparently the intermediate or dorsal one. At the extremity of the small lateral spine, one of the strong lateral keels is well exhibited; and the small central spine displays distinct evidence of two keels. In many of our sections these ridges assume the very same appearance which we see in this figure; and they are all found to be composed of enamel, as these points are represented to be in *Ochlodus*; and there can be no doubt that the trace of enamel described and indicated at *g*, on the large spine, is a lateral view of the keel the lower point of which terminates at *g*.

We thus find that *Ochlodus* does not only agree in general form, but even in the minutest details, with *Diplodus*; and we can find no distinguishing histological characters on which to found this so-called genus.

Ctenoptychius pectinatus, Agassiz.

This species is not uncommon in the shales at Newsham and Cramlington. One of the authors of this paper has a large suite of specimens gathered at these localities; they agree perfectly well with *C. pectinatus*, though they usually have a greater number of denticles than represented in the figure in 'Poissons Fossiles.' The number ranges from eight or nine to fifteen or sixteen. Well developed specimens measure one-quarter of an inch wide and a little less high. They are in the form of wide, flattened plates, with the upper margin a little arched transversely and denticulated, the denticles being rather obtusely pointed, compressed from before backwards, and recurved; the marginal surface is concave behind and convex in front, and thickened posteriorly, where it is strongly defined from the base by a deep transverse constriction. A lateral section consequently presents a sigmoid curve, the lower member of which is the larger and less bent. The whole of the denticulated margin, including the denticles, is coated with a thin layer of enamel, only traces of which can usually be seen in sections. The base narrows suddenly immediately below the denticulated margin, and is frequently considerably longer than the upper glazed or enamelled por-

tion; and the lower margin is often produced into two or more fang-like processes.

In the base of each denticle there is a small pulp-cavity that extends only a short way upwards, and is in direct communication with the wide medullary canals of the basal portion, which are for the most part elongated; but in this respect there is considerable variation. The canals are most elongated, as might be expected, in elongated specimens. The dentinal tubules, which are nearly vertical, are coarse, fasciculated, and much branched; and the osteo-dentine of the base exhibits also a few branched tubules, strongest and most numerous above and at the margins; below they are comparatively small and obscure.

A few specimens have occurred which are much elongated transversely, and have upwards of twenty denticles; these are probably *C. denticulatus* of Agassiz. *Otenoptychius* is probably a dermal tubercle, though it certainly has more the appearance of a tooth than either *Diplodus* or the spined dermal tubercles which have been assigned to *Gyracanthus*.

Note.—That *Ageleodus diadema* of Prof. Owen (pl. 4) is the fossil above described cannot for a moment be doubted. In general form, size, number and character of the denticles, as seen in section, all exactly agree; and there is no difference whatever in the histological features: only the specimen figured and described in the paper referred to is shorter than usual; hence the medullary canals are not so decidedly elongated as they frequently are. Now no palæontologist would hesitate to pronounce our specimens to be *Otenoptychius pectinatus* of Agassiz. It is therefore futile to assert that the figure of the structure of this genus in the 'Poissons Fossiles'* shows "at a glance" that it is generically distinct from *Ageleodus*; and it is certainly erroneous; the difference is merely a difference in degree. The medullary canals are more elongated and somewhat more regularly parallel in Agassiz's figure than they are in our specimens, in many of which, however, the parallel and elongated character predominates. In fact there is quite as great a difference in this respect between individuals of our suite of specimens as there is between some of them and Agassiz's figure referred to. And it must not be forgotten that this figure represents the structure in a different species. We repeat, then, that no generic difference is perceptible at a glance. M. Agassiz certainly states that the substance at the base of the tooth is perfectly homogeneous. In some of our specimens, too, the basal portion has lost nearly all traces of

* Tome iii. pl. M. figs. 4, 5.

structure; but such specimens are mounted in balsam, which, we have seen, is liable to render minute structure invisible. It is therefore not improbable that the specimens of *M. Agassiz* may have been mounted in this medium; and it is equally likely that the minute structure was not preserved in the fossil examined by him. Such discrepancies must be expected in the examination of *fossils*; and accordingly we have already seen that the minute structure in *Ctenodus* had escaped the observation of that naturalist.

In *Ageleodus* we see another striking instance of the danger of trusting entirely to the sections of objects not previously understood. From this cause the denticles are described as if their whole contour was seen, whereas there is nothing but the mere stumps left in the section, the crowns all having been cut away in making it. As the denticles are (as we have already stated) recurved, they must necessarily, to a great extent, be removed in such a section as that figured. Had this been previously known, the bases of the denticles could never have been mistaken for their crowns, nor could the latter have ever been described as "broader than they are high;" nor could it have been stated that they all "terminate obtusely; and this seems to be an original form, not due to wear or abrasion." In fact, Prof. Owen describes merely a diagonal section of the basal portion, and supposes that he describes the whole denticle. This author has likewise been deceived into the belief of the existence of a common pulp-cavity, by the removal in the section of the osteo-dentine near the centre of the specimen. Here all the substance has been ground away in consequence of the lateral sigmoid bend before described. A lateral section proves that no such cavity exists; and, indeed, the large series of sections now before us, and which were made many years ago, entirely disprove this assertion. The inference drawn from the supposed presence of this cavity is therefore of no avail.

We have now examined the whole of the new genera and species of Fishes and Batrachians proposed by Prof. Owen in his paper published in the 'Transactions of the Odontological Society,' and find ourselves compelled to conclude that there is positively not a single novelty in the whole series. Thirteen genera were enumerated in the "Abstract" of the paper as read; in the paper as published there are only twelve, one (entitled "*Oreodus*") having been withdrawn. It is unfortunate that some circumspection had not been also observed with regard to the remaining twelve, which, we fear, are fated to fall into the like obscurity. We have found as we approached the "New Coal Fishlets" that they gradually

dwindled away, and at length entirely disappeared; or rather we perceived that they never had had any real existence, and that the "Minnows and Sticklebacks" of the Northumberland coal-shales have yet to be discovered.

EXPLANATION OF THE PLATES.

PLATE XIV.

- Fig. 1.* Sternal plates of *Pteroplax cornuta*, about half the natural size: *a a*, lateral plates; *b*, posterior portion of central plate appearing from beneath the former; *c*, posterior process.
- Fig. 2.* View of underside of central sternal plate, two-thirds natural size: *a*, perfect lateral wing or lobe; *b*, posterior process.
- Fig. 3.* Præmaxilla of *Pteroplax cornuta*, natural size, the apices of the teeth having been restored: *a*, anterior extremity; *b*, posterior articular process; *c c*, mucus-grooves; *d*, external nostril.

PLATE XV.

- Fig. 1.* Cranial shield of *Pteroplax cornuta*, about two-thirds natural size: *a*, frontals; *b*, parietals; *c*, occipitals; *d*, postfrontals; *e*, epiotics; *f*, parietal foramen; *g*, posterior horns; *h*, inner posterior orbital border.
- Fig. 2.* Front view of vertebra, three-fourths natural size: *a*, centrum, showing a minute notochordal foramen in the centre; *b*, neural canal; *c*, spinous process, restored from another specimen; *d*, transverse process; *e*, anterior zygapophysis.
- Fig. 3.* Inside view of mandibular ramus of *Palæoniscus*, showing the row of laniary teeth almost perfect, but turned by pressure so as to present their sides; the row of small exterior teeth is buried in the matrix: *a*, anterior extremity; *b*, posterior articular process; *c*, impressions of the surface-striae in the matrix, a portion of the bone having been removed.
- Fig. 4.* External view of a maxilla of another species of *Palæoniscus*, exhibiting both rows of teeth, the laniary and the small exterior teeth appearing to be in the same line, on account of pressure: *a*, anterior extremity; *b*, tooth figured in next plate.
- Fig. 5.* Inside view of a portion of the alveolar border of the jaw of *Palæoniscus*, showing the row of laniary teeth within the small exterior row: *a*, laniary teeth; *b*, impressions in the matrix of the teeth of the exterior row; *c c*, three of the small exterior teeth left adhering to the matrix.
- Fig. 6.* External view of a mandibular ramus of *Acanthodopsis Wardi*: *a*, anterior extremity; *b*, posterior extremity; *c*, styliform process attached to the denticerous bone, *d*.

PLATE XVI.

- Fig. 1.* Tooth from maxilla of *Palæoniscus* (Pl. XV. fig. 4 *b*): *a*, enamel-tip.
- Fig. 2.* Section of tooth of *Palæoniscus*, exhibiting the cap of enamel, *a*; *b*, film of enamel coating the crown, very frequently absent.
- Fig. 3.* Section of tooth of *Pygopterus*, from Agassiz, showing the enamel-tip, *a*.

Fig. 4. Section of the upper portion of the tooth of *Polypterus*, from Agassiz, showing the cap of enamel, *a*.

Fig. 5. Section of portion of maxilla of *Rhizodopsis*, much enlarged, exhibiting the bony pillars supporting the teeth: *a a*, bony pillars; *b, b*, teeth in an abraded condition, the enamel having all disappeared, and, in some instances, portions of the dentine.

XLVI.—On the Development of the Position of the Eyes in Pleuronectidæ. By Prof. J. C. SCHIÖDTTE. Communicated by C. A. Gosch, Esq.

[THE question of the asymmetry of Pleuronectidæ has of late attracted so much attention, and we possess so few reliable descriptions of the appearances presented by very young specimens (whereby alone that question can be solved), that the following observations on this subject by Prof. Schiödtte will doubtless be found highly interesting, not only to ichthyologists, but to zoologists generally. I wish particularly to draw attention to two of his results, now established by actual examination of successive stages of development of the same species, viz. :—first, that the eye of the blind side glides across the head in front of the dorsal fin without ever disappearing from view, and, when arrived on the other side of the dorsal fin and clear of it, recedes backward alongside the fin, which does not, as supposed by some, prolong itself after the passage of the eye; and, secondly, that this shifting of place is a very slow process, for which, in all probability, preparation is made in the fœtus.

Prof. Schiödtte's article is destined shortly to appear in the fifth volume of the 'Naturhistorisk Tidsskrift,' but having been favoured by the author with a separate impression, I am enabled already to present it to the readers of the 'Annals.' The author begins by describing the specimens which form the principal material of his treatise in the following manner.]

On examining a young specimen of *Rhombus barbatus* which lies before me, and which measures 18 millims. in length from the apex of the closed lower jaw to the extreme end of the caudal fin, I observe that the ramifications of the muciparous canal on the head are not traceable; but the outline of the parts of the mouth, of the præoperculum, and the opercula are clearly perceptible through the skin, as well as the layers of the muscles, particularly of the great masseter on the right side. The left eye stands very nearly opposite to the middle of the upper jawbone. The right eye is placed at the top of the head, in front of the dorsal fin, but so much inclined to the left, that only one-third of its surface is visible when the fish

is viewed from its right side. The right eye is rather more round in outline—that is, a little shorter and broader than the left. This difference is caused by its being under pressure, wedged in as it is between the anterior frontal bones and the dorsal fin; and the pressure causes the interspinous part of the dorsal fin to form a small slightly upward-curved projection above the eye.

The smallest of three young of *Pleuronectes platessa*, which I have also before me, has a length of only 10 millims., the measure being taken as above. The ramifications of the muciparous canal cannot be discovered on the left (blind) side of the head, whilst on the right side they are just traceable as indistinct lines; but no ducts are to be distinguished. The whole head has a clumsy, toad-like shape, the parts of the mouth presenting soft swelling outlines. The right eye stands over the beginning of the lower third of the maxillary bone. The left eye stands at the top of the head, so much inclined to the right, that from the left side only a trifle more than one-third of the pupil can be seen; it stands in front of the dorsal fin, so that the front ray of the latter is just behind the end of the left and beginning of the middle thirds of the eye.

On comparing with this the head of another young *P. platessa*, which measures 14 millims. in length, one observes at once that the head has a somewhat less clumsy appearance, and the ramifications of the muciparous canal are more clearly observable. The position of the left eye is so far changed that when the head is viewed straight from the left side the pupil is invisible, only a part of the iris can be seen; and its position with regard to the dorsal fin is at the same time altered so that the latter touches the left margin of the eye, which cannot now be described as entirely situated in front of the dorsal fin; for the foremost ray of the fin stands at the side of the eye, a little in advance of the extreme posterior margin of the eye. When, therefore, the fish is examined from the blind side, the outline of the eye cannot be followed in its whole extent, the posterior extremity being hidden from view behind the first ray of the dorsal fin.

In a third young *P. platessa*, measuring 40 millims. in length, the head presents almost the same pointed shape as in the adult fish. The ramifications of the muciparous canal are much more distinct, and the ducts are easily distinguished on the preopercular branch on both sides, as well as on the infra-orbital branch on the blind side. The right eye stands over the lower extremity of the upper jawbone; but, in spite of this more depressed position of the right eye, the distance between the eyes is nevertheless only a little greater than in the speci-

men last described, on account of the change which is observed in the position of the left eye, which is now placed not only above the right eye, but at the same time a little behind it. The left eye is entirely transferred to the right side, though it stands so high on this side that its pigment, dimly shining through the skin, can still be seen from the left side as a small dark border. A striking evidence of its having receded further back is afforded by the fact that the first ray of the dorsal fin in this specimen stands so far forward, in comparison with the eye, that it is on a level with the middle of its left margin, whilst the third ray occupies the place relatively to the eye which in the former specimen is occupied by the first ray.

The specimens of young *Hippoglossus pinguis* which I have before me present a similar progressive development. The smaller is 57 millims. long. The outlines of all the superficial parts of the skull are distinctly seen through the skin, as well as the branches of the muciparous canal and their numerous ducts. The left eye is placed at the top of the head, so much inclined to the left (blind) side, that from the right side the iris is only partly visible, and the pupil altogether invisible; it is placed straight in front of and close to the dorsal fin, which points alongside the right margin of the pupil. On the head of a second specimen, which is nearly twice as large (100 millims.) the ducts of the muciparous canals are evidently more numerous, and the infraorbital branch on the left (blind) side, which on the smaller specimen appears curved, is here almost straight. It has got space to grow straighter; for on this specimen the left eye has moved across the head so much that it now inclines as much to the right side as formerly to the left; and whilst in the smaller specimen it stood nearly straight before the dorsal fin, the latter would, if prolonged in the larger specimen, cross the eye just inside its left margin. That the eye is under pressure, wedged in between the interspinous part of the dorsal fin and the anterior frontal bones, is evident from an indenture in its outline on the posterior margin; and this pressure evidently cannot cease till the eye, gliding still further to the right, has got clear of the dorsal fin.

In order to explain how the upper eye of the Pleuronectidæ comes into that position relatively to the dorsal fin which it occupies in the adults, naturalists have had recourse to the hypothesis that the dorsal fin prolongs itself in a forward direction when the upper eye, by the torsion of the head, has come into its final place. This hypothesis was first proposed by Van Beneden (Ann. Sc. Nat. sér. 3. t. xx., "Note sur la structure des Pleuronectes") and has been adopted also by Dr. Traquair, in his exhaustive

instructive treatise "On the Asymmetry of the Pleuronectidæ" (Trans. Linn. Soc. 1866, vol. xxv. p. 263)*. The fact, however, that the young fish, at least those examined by me, possess the same number of rays in the dorsal fin as the adults, would in any case render this theory very doubtful, even if it had not now been proved by the observations above detailed that *the eye of the blind side does not only glide over from its own to the eye-side of the fish, but, when arrived here, it recedes a little along the dorsal fin*. It is consequently the eye which moves round the anterior end of the fin, not the fin that prolongs itself past the eye. A comparison between different specimens of the same species shows that the change of place is rather a slow process. On the head of the young *Rh. barbatus* above referred to, which is 18 millims. long, the eye is still quite in front of the fin; on another specimen of the same species which I have before me, and which is 45 millims. long, the centre of the eye is on a level with the second and third ray of the fin; on a third specimen, 90 millims. long, the eye is on a level with the third and fourth rays, and on a fourth specimen, 115 millims. long, it has receded as far as the fourth and fifth rays.

The total length of the first-described young *P. platessa* was, as stated, 10 millims. including the caudal fin. If, then, we take into consideration the proportionally great size of the eggs of this species, which measure 2 millims. in diameter, as well as the fact that the fish-embryo is, as it were, rolled up inside the ovum, it becomes clear that the specimen in question must have been caught not many days after having left the egg. Even allowing a margin for more rapid growth during the first days after hatching, it must be conceded, on comparing the three specimens above described, respectively 10 millims.,

* Dr. Traquair ascribes to Fr. Rosenthal the opinion that the upper eye of the flounders attains to its anomalous final position by passing under the dorsal fin right through the head; but, although Rosenthal's expressions (Ichthyotomische Tafeln, ii. 3, Berlin, 1821, 4. p. 5) are vague enough, and may be so interpreted, I think that he may equally well be supposed to have intended only, by a sort of figure of speech, to illustrate the peculiarity of the flounder-skull. The idea that a highly complicated organ, after having attained its full development, should loosen itself from the ground out of which it has grown, wander about amongst other utterly different organs of the body—nay, even go right through the body of the animal, in order to turn up again on the other side and take root there—this idea is one which scientific zoology now-a-days can only put aside as a curiosity. I therefore think it due to the memory of so able an anatomist as Rosenthal that such a crude opinion should not be ascribed to him except on more cogent grounds, although the plate in the explanation of which the expressions in question occur was published as early as 1821—that is, only a few years after the foundation of comparative anatomy by Bichat.

14 millims., and 40 millims. long, that the development of the position of the eyes after hatching is upon the whole a very slow process, and that consequently the position of the eye on the future blind side can scarcely have been quite symmetrical even in the new-born fish. In the young fish of 10 millims. length the anomalous eye has already, in every essential particular, the same position with regard to the bones of the skull as in the adult, being placed in its orbit; and I therefore consider it in the highest degree probable that the arrangement of the frontal and anterior frontal bones round the eye of the future blind side takes place in all essential points already in the embryonal state; nor could the matter very well be imagined otherwise according to all we know about the formation of the embryo. But then the whole case falls under a very well-known biological law, and becomes plain enough. The young *Pleuronectidæ* are born with a position of their eyes calculated for life nearer the surface of the water, and grow slowly and gradually more asymmetrical in proportion as the adult fishes seek more the bottom of the sea, or, at any rate, are more calculated upon movement along a firmer surface*. Hence the well-known long series of forms exhibiting a gradual transition, from *Hippoglossus pinguis*, which does not in any considerable degree alter the shape in which it leaves the ovum, to the soles, which are entirely thrown on one side. It appears, however, that *Hippoglossus pinguis* is not the least asymmetrical form of the family. I have before me two perhaps not quite adult specimens of an apparently undescribed oceanic flounder, taken in the Atlantic, which I propose to call *Bascanius tardifer*, n. s., and which, in the series above alluded to, would take place before the *Hippoglossus*. It is, as is the case with other oceanic animals, clear as water, very high and narrow, about 25 millims. long, foliaceous, almost symmetrical; only the left side is a little more developed, and the eye on that side is placed a little lower on the head. The greatest height of the body is at the commencement of the anal fin, where it almost reaches one-half of the total length. The muciparous canal makes a very slight bend over the pectoral fin. The dorsal fin reaches the nostrils in front, and approaches behind (as also does the anal fin) close to the caudal fin, which is slightly rounded at the end; the open space between the ventral fin and the anal fin is longer than the ventral fin itself. The rays of the fins exhibit only few and long joints; their number I find to be in my two spe-

* Monstrosities, caused by the eye of the blind side being arrested in its process of transfer in front of the dorsal fin, have long been known. Comp. Dr. Traquair's treatise, p. 265.

cimens, in the dorsal fin 110–112 rays, in the anal fin 78–80, in the caudal fin 16–18. The entire body of the fish is rather closely strewn with small protuberances, which, on the head, stand without perceptible order, but on the greater part of the body, on the interspinous part of the dorsal and anal fins and on the base of the caudal fin are arranged in longitudinal rows. These protuberances are almost round, about 0·1 millim. in diameter, almost flat at the top, and armed with a few very small and short spines; only along the extreme edge of the interspinous part of the dorsal and anal fins and on the base of the caudal fin these protuberances are more projecting, almost semiglobular, equipped with more numerous and longer spines. The mouth is small, delicately formed, both jaws well armed with pointed, needle-shaped teeth. The eyes are round, very projecting, with a broad white ring of sclerotica visible around the iris. Between the right eye and the dorsal fin there is a semiluniform depression, where the body is so thin that it easily breaks to pieces or separates itself from the dorsal fin when incautiously manipulated. In that case, of course, a part of the opposite eye is seen through the hole, and, to a superficial examination, the extraordinary appearance is presented of a flounder having two eyes and a half.

BIBLIOGRAPHICAL NOTICE.

The Birds of South Africa. A Descriptive Catalogue of all the known Species occurring south of the 28th Parallel of South Latitude.
By EDGAR LEOPOLD LAYARD, F.Z.S. &c. Cape Town: 1867.
(London: Longmans.) 8vo, pp. 382.

"CONTRIBUTORS cannot be criticised:" this is the principle on which a good many publications are conducted; and in politics or in general literature it may answer well enough. Naturalists, however, are exempt from any such consideration. They may, nay they are bound to say what they think of the labours of their fellows. Hence, in speaking of Mr. Layard's recent work, we dismiss from our thoughts the fact that he has been, and we hope will again be, one of the contributors to this Journal. The Ceylon ornithologist whose graphic pen enlivened our pages fifteen years ago, and more, must stand at our bar and listen to our summing-up without being able to call the court as a witness to his character. Indeed he has entirely changed his mode of life since then—of necessity, it need scarcely be said (for no man in his senses would do so willingly); he has abandoned the jungle and the forest for the museum and the library. In this new sphere he is certainly not yet so successful; but *non ovis contigit*. A dourly 'Descriptive Catalogue' affords but little scope for that kind of talent which distinguished his former writings. It must be judged by other rules.

First of all, in such a case, to make his descriptions complete and of the most service, the author should make them also comparative. This Mr. Layard has not done. His descriptions have been penned at various times and in various places, which was probably unavoidable; but, then, they should have been subsequently compared with one another, so as to ensure their symmetry. For species the author has not himself seen, of course he is quite right to quote the original descriptions unaltered; and this, the safest plan, Mr. Layard appears to have followed. But we are speaking of descriptions written by himself; and the "broken and disjointed style" for which he in a measure apologizes in his "preface" is here unnecessary: it not merely disfigures the book, but is an absolute hindrance to its utility.

The next important point is that the author of such a Catalogue as the present should be very precise in quoting from his predecessors. But here there is much room for improvement. Mr. Layard is weakest in his "bookwork." We have no bibliographical information afforded us, no list of authorities given, and the references to the publications cited are now put in one form and now in another, while many, and those most necessary, references are not made at all. This is especially to be regretted in a book on South-African birds; for respecting the ornithology of few parts of the world are the materials so widely scattered and so little digested. It would have been a great achievement for Mr. Layard to have drawn up his references on a well-arranged system. Very likely it would have been a troublesome job, but still one quite feasible and quite worth the labour bestowed upon it. Besides, we are much mistaken if it could have been done anywhere better than at Cape Town. Take for instance the numerous contributions to South-African ornithology by Sir Andrew Smith. In this country we doubt whether any library contains a complete series of them. Some of his descriptions originally appeared in newspapers published in the colony; and at the Cape, if anywhere, copies of these papers should be accessible. Now Mr. Layard evinces no sign of having made search for them, and yet, from all we have heard of the public library of Cape Town, they are to be found there.

We do not make these depreciatory observations without reason. The fact is that Mr. Layard's book, as far as it goes, is so good and so useful, that it ought to be better and more useful. He modestly says of it that "it is a move forwards, and may serve as a foundation for the labours of others whose opportunities may be greater." But we would impress upon Mr. Layard that he has the greatest opportunities of any one. We believe that he has informed his friends at home that he is already preparing a second edition. We are very glad to hear it; but we trust he will take care that the work undergoes a very thorough revision before a second edition is printed. Moreover we venture, in addition to the hints for its improvement given above, to recommend him to eliminate all those species, now included, which he himself shows have been erroneously introduced in the South-African fauna. By doing this he will leave

more room for the proper treatment of the rightful natives. To our readers we would give the advice that they should at once purchase the 'Birds of South Africa,' as, the sooner this edition is sold off, the sooner we may expect the new and improved one. To Mr. Layard we tender our best wishes for his health and zeal, that he may successfully prosecute his task.

MISCELLANEOUS.

Natica catenata (Philippi).

To the Editors of the Annals and Magazine of Natural History.

GENTLEMEN,—What is the true habitat of *Natica catenata*?

Reeve, in his monograph of the genus, gives "Sicily," but without quoting any authority.

Moreover Philippi, whose description Reeve copies, in his original account of the species (Proc. Zool. Soc. 1851, p. 233), in which he describes it from specimens in the collection of Mr. Cuming, assigns no locality; it may therefore be presumed that none was attached to the Cuming specimens.

Some shells in the collection of this Museum, belonging to this species, are labelled as from Mazatlan; but no authority is given for the habitat. I should therefore be glad to know if any examples of this species have been recently obtained, and, if so, from where.

I perceive Reeve changes *Natica Incei*, Philippi, into *N. Incii*, and *Natica caribbæa*, Philippi, into *N. caribbæa*.

Do not these seem rather unnecessary alterations, and apparently founded on no good reason?

I have, &c.,

Institution, Bristol.

T. GRAHAM PONTON.

Balatro calvus, a New Genus and Species of Rotatoria entirely destitute of Vibratile Cilia. By E. CLAPARÈDE.

M. Meczniow has lately described (Siebold and K  lliker's 'Zeitschrift,' 1866, p. 346), under the name of *Apsilus lentiformis*, a Rotatorian entirely destitute of vibratile cilia; and M. Clapar  de now communicates an account of an animal of the same kind observed by him some years ago in the Seime, a small river of the Canton of Geneva. It was found creeping on the bodies of *Trichodrili* and other small Oligoch  ta.

The body of this animal, to which M. Clapar  de gives the name of *Balatro calvus*, is more or less vermiform and very contractile. Its posterior extremity (foot) is divided into two lobes, of which the ventral is semilunar, with acute angles which are capable of invagination. The dorsal lobe forms a flattened cylinder terminated by three mammill  . Between the two lobes the anus is situated.

The anterior extremity, which is indistinctly annulated, is capable of retraction as in other Rotatoria. The mastax is not largely developed and is armed with a very small incus and with two curved

mallei; it opens directly into a thick-walled intestine, the inner layer of which is brownish. This intestine is more simple than in the Rotatoria generally; it extends in a straight line from the mouth to the anus, and its narrowed anterior part scarcely merits the name of œsophagus. No glands were observed in connexion with the stomach. When the animal is extended the curved mallei project externally.

All the individuals observed were females. The ovary occupies the ventral portion of the body, beneath the intestine; the mature ovules are ovoid, and occupy the posterior extremity of the body.

M. Claparède characterizes his genus *Balatro* as follows:—Body vermiform, very contractile; posterior extremity terminated by two lobes: one ventral, of a semilunar form, transverse; the other dorsal, nearly cylindrical, acting as a foot. Mallei in the form of crooks. No vibratile organs; no eyes.

Besides *Apsilus* and *Balatro*, *Taphrocampa* of Gosse is a genus of Rotatoria destitute of vibratile cilia. Mr. Gosse placed it originally near *Notommata* and *Furcularia*, but has since removed it to the neighbourhood of *Chaetonotus* among the Gastrotricha. In this M. Claparède thinks he is wrong, as *Taphrocampa* possesses a mastax the structure of which is very near that of the *Furcularia* and *Monocerca*.

M. Dujardin also describes his genus *Lindia* as destitute of cilia; and M. Claparède regards it as nearly allied to his *Balatro*, which is still more closely related to *Albertia* (Duj.).—*Annales des Sciences Naturelles*, série 5, tome viii. pp. 12–16.

Occurrence of Terebratula (Waldheimia) pseudo-jurensis (Leymerie) in England. By J. F. WALKER, B.A., F.G.S. &c.

Among the Brachiopoda which I have obtained from the Lower Greensand deposit at Upware, Cambridgeshire, I detected a species which, on examination, proved to be the *Terebratula pseudo-jurensis* described by M. Leymerie (Mém. Soc. Géol. Fr. 1842, tome v. p. 12) from the Neocomian beds of France. Mr. Keeping has also obtained specimens of this fossil for the Woodwardian Museum. As the species had not previously been discovered in this country, I thought that a notice of its occurrence would have some interest for the readers of the 'Annals.'

The inspection of the loop proves that this species is a *Waldheimia*.

Fossil Ivory.

The ivory of Mammoth-tusks is an article of trade peculiar to Siberia. Although forming too slight an item to be taken into consideration in the statistical returns of the trade of Russia, still, as this ivory formed one of the earliest articles of export from Siberia to China, the few statistics I have been able to collect with reference to this curiosity of commerce may not be without interest.

About 40,000 lbs. of fossil ivory (that is to say, the tusks of at least 100 mammoths) are bartered for every year in New Siberia, &c.

that, in a period of 200 years of trade with that country, the tusks of 20,000 mammoths must have been disposed of, perhaps even twice that number, since only 200 lbs. of ivory is calculated as the average weight produced by a pair of tusks.

As many as ten of these tusks have been found lying together in the "Tundra," weighing from 150 to 300 lbs. each; the largest are rarely seen out of the country, many of them being too rotten to be made use of, while others are so large that they cannot be carried away, and are sawn up in blocks or slabs on the spot where they are found, with very considerable waste, so that the loss of weight in the produce of a tusk before the ivory comes to market is of no trifling amount. A large portion of this ivory is used by the nomad tribes in their sledges, arms, and household implements; and formerly a great quantity used to be exported to China,—a trade which can be traced back to a very distant period; for Giovanni de Plano Carpini, a Franciscan Monk, sent by Pope Innocent IV., in 1246, into Tartary, describes a magnificent throne of carved ivory, richly ornamented with gold and precious stones, belonging to the Tartar Khan of the Golden Horde, the work of a Russian jeweller, the slabs of which were so large that they could only have been cut out of large mammoth-tusks.

Notwithstanding the enormous amount already carried away, the stores of fossil ivory do not appear to diminish; in many places, near the mouths of the great rivers flowing into the Arctic Ocean, the bones and tusks of these antediluvian pachyderms lie scattered about like the relics of a ploughed-up battlefield, while in other parts these creatures of a former world seem to have huddled together in herds for protection against the sudden destruction that befell them, since their remains are found lying together in heaps.

In 1821, a hunter from Yakutsk, on the Lena, found in the New-Siberian Islands alone 500 poods (18,000 lbs. English) of mammoth-tusks, none of which weighed more than 3 poods—and this notwithstanding that another hunter, on a previous visit in 1809, had brought away with him 250 poods of ivory from the same islands. The inhabitants on the mainland pile up in heaps the tusks which are found scattered about on the "Tundra," and convey them in large boats up the Lena. In the period from 1825 to 1831, at least 1500 poods reached Yakutsk yearly; the trade in fossil ivory at Turuchansk, on the Jenissei, has for many years past amounted to from 80 to 100 poods annually, and that of Obdorsk, on the river Ob, from 75 to 100 poods.

Entire mammoths have occasionally been discovered, not only with the skin (which was protected with a double covering of hair and wool) entire, but with the fleshy portions of the body in such a state of preservation that they have afforded food to dogs and wild beasts in the neighbourhood of the places where they were found. They appear to have been suddenly enveloped in ice or to have sunk into mud which was on the point of congealing, and which, before the process of decay could commence, froze around the bodies and has preserved them up to the present time in the condition in which they perished. It is thus they are occasionally found when a land-

slip occurs in the frozen soil of the Siberian coast, which never thaws, even during the greatest heat of the summer, to a depth of more than 2 feet; and in this way, within a period of a century and a half, five or six of these curious corpses have come to light from their icy graves.—*From a Report by Mr. Lumley, H.M. Secretary of Embassy and Legation, Russia, 1867.*

On the union of the Tympanic Bone with the Lower Jaw occurring in the Marsupials during development, as a fresh proof of the agreement of this bone with the os quadratum of the other classes of Vertebrata. By Professor W. PETERS.

The articulation of the lower jaw in the Mammalia is effected, as is well known, by means of a condyle, which fits into an articular cavity of the zygomatic process of the temporal bone, either directly or by the mediation of an interarticular cartilage, whilst in the other classes of Vertebrata the lower jaw is united, by means of an articular cavity, with the condyle of a bone which, after Hérissant's example, is usually called the *os quadratum*.

This bone is either articulated to the cranium (Birds, Lizards, Snakes), or united to it by suture (Crocodiles, Tortoises, Batrachia). In the former case it may assist in the formation of the tympanic cavity and in the attachment of the tympanic membrane; in the second it always does so. This bone may be united to various parts of the temporal bone, and to the pterygoid, sphenoid, and occipital bones. Of all these unions, that with the temporal bone, and, indeed, with its squamous portion, is alone constant, whilst all the others may be wanting.

The question, with what part of the mammalian skull the quadrate bone is homologous, has given rise to many disputes, and has been answered in various ways:—

1. Hérissant regarded the ascending ramus of the lower jaw as the part corresponding to it.

2. Tiedemann, Platner, and apparently Küstlin regard the quadrate bone as a part separated from the squamous (and petrous) portion of the temporal.

3. Geoffroy St.-Hilaire regarded the *os tympanicum* with the *processus styloideus* as representing it.

4. Oken, Cuvier, Blainville, Spix, Meckel, Carus, R. Wagner, Hallmann, Stannius, Owen, and others interpret it as the *os tympanicum*.

5. Reichert, O. Schmidt, and Huxley declare that, as Carus had previously supposed, the incus or the middle ossicle of the ear in the Mammalia is the quadrate bone of the other Vertebrata.

I had hitherto adhered to the opinion that the *os tympanicum* of the Mammalia was homologous with the *os quadratum* of the other Vertebrata, as also used originally to be indicated by J. Müller, in his lectures, whilst subsequently he used the expression "quadrate bone." To me the proof of this interpretation lay in the similar position of the bone in its relations to the tympanic cavity and membrane, and in the union of the bone with the sphenoid occurring

even in the Marsupialia. The absence of the articulation with the lower jaw seemed to me to be of the less importance, as the quadrate bone is also inconstant in its other unions, and only that with the squamous portion of the temporal is constant. That a distinct bone, which is constant throughout the whole series of the Mammalia, should at once disappear, seemed to me to be improbable; nor could I accept the small fragments of bone found in birds, by some observers, as representing it.

I could never reconcile myself to the opinion, supported especially by Reichert and Huxley, that the incus of the Mammalia is the homologue of the quadrate bone, both on account of the objections raised against it by J. Müller*, who had the opportunity of carefully examining the preparations made by M. Reichert for the proof of his opinion, and also because it seemed to me very improbable that the incus, which in the *Ornithorhynchus* does not occur at all, or only appears as a minute rudiment, should suddenly make its appearance again in the Birds in such gigantic proportions and in a totally different position, not to mention the difficulty of interpreting the incus and malleus which certainly likewise occur in a cartilaginous rudimentary state in Birds†.

Leaving this last circumstance, especially, out of consideration, from the similarity which two parts issuing from or connected with Meckel's process (namely, the articular portion of the lower jaw in Birds and Amphibia, and the malleus of the Mammalia lying behind the lower jaw) present to one another at a certain period of development, a conclusion is arrived at as to the homology of these parts, upon which a number of other hypotheses upon the homologies of other parts of the skeleton (*e. g.* in the fishes) are supported; and the latter, of course, fall if the former be erroneous.

At the present moment, when I am occupied with the conclusion of other investigations, I should hardly have been led to take up again a question which has been so long in dispute, if Mr. Huxley, who had already ‡ given his decided adhesion to the opinion of the homology of the quadrate bone and the incus, had not, in a memoir upon the classification of Birds, otherwise containing much that is admirable, and which is destined to find a very large circle of readers, represented the matter as if all doubt upon the point in question had been got rid of §.

As it appeared to me that a solution of the question was most likely to be found among the lower Mammalia, which approach Birds in so many respects, I first sought for it among the Monotremata, but have been compelled to interrupt this investigation for the present, and in the next place took young Marsupials in hand.

* Archiv für Anatomie und Physiologie, 1838, p. clxxxvii.

† Even if there may be some doubt with regard to the incus in Birds, this must be quite baseless with respect to the malleus. But the bone which is denominated incus in the Mammalia is always situated between the stapes and the malleus.

‡ Lectures on the Elements of Comparative Anatomy. London, 1864, pp. 229 *et seq.*

§ Proc. Zool. Soc. London, 1867, p. 416.

In a young *Halmaturus Bennettii*, measuring (without the tail) 85 millims., the *os tympanicum* forms a ring broken through before and behind, just as in the developed state in the *Monotremata*. The anterior and stronger part of this ring divides into a fork above, and embraces Meckel's process from without and behind, whilst beneath it fits exactly with a convexity upon the inner surface of the ascending portion of the lower jaw, and with a smooth articular surface into the upper concave surface of the incurved angle of the jaw.

I find the conditions exactly similar in older examples of *Didelphys aurita*, only that the tympanic bone is already separated by a thin layer of connective tissue from the angle of the lower jaw.

From this the peculiar characteristic formation of the angle of the lower jaw in the lower *Mammalia* is at once explained; its inwardly projecting portion corresponds, as a provisional articular process, with the permanent inner articular process of Birds.

It is possible, and appears to me even probable, that the malleus in Birds contributes to the formation of the quadrate bone, as in Birds there is still a second outer articular cavity, no part corresponding to which exists in the *Marsupialia*. This will probably find its explanation among the *Monotremata*, as in *Ornithorhynchus* a peculiar external process of the lower jaw occurs, corresponding in position to the outer articular process in Birds; and I hope soon to be able to make further communications upon this point.—*Monatsber. Berl. Akad. der Wiss.* Nov. 21, 1867, pp. 725-729.

On the Tympanic Bone and Ossicles of the Ear in the Monotremata, in connexion with the question of the interpretation of the Quadrate Bone in Birds. By Professor W. PETERS.

My hope of obtaining very young *Monotremes*, and by their investigation solving, as I expected, the question of the homology of the quadrate bone of birds with the tympanic bone, has not been fulfilled; but yet, from the examination of a not completely developed skull of *Tachyglossus hystrix*, for which I am indebted to the kindness of Dr. Möbius, and from that of a still younger skull of *Ornithorhynchus* belonging to the Zoological Museum of Berlin, some results have been obtained which seem to me worth communicating.

The *os tympanicum* of *Tachyglossus* is, indeed, at a later period amalgamated with the long process of the malleus, but the boundary between them may still be distinctly recognized. It then forms a half ring, the thinnest middle part of which is applied directly to the *os pterygoideum*, and at the spot which lies nearest to the apex of the long process of the malleus it is but little widened. But in the young specimen now before me, this entire region is the broadest of the ring, and moreover it is furnished on its lower free surface with a slight convexity, which corresponds to the inner concavity of the small angle of the lower jaw, and which, in all probability, and judging from the conditions in the *Marsupials*, was previously united like a joint with this cavity. The extraordinary size of the long process of the malleus is likewise remarkable; in proportion to the

entire size of the animal it shows a more gigantic development than in any other mammal. Exteriorly the malleus unites by an articulation with the *squama temporalis* at a point which appears to be depressed by the externally projecting hinder extremity of the zygomatic bone*. Nevertheless this union does not take place directly, but by means of a small acutely triangular ossicle, widening from before backwards, which, on careful examination, proves to be nothing but a portion of the incus which is amalgamated with the malleus†.

But if the malleus be examined on its upper surface, a distinct suture appears to be present in places at the point where the long process unites with the malleus; and this leads us to expect that in very young animals a dividing suture will be found here.

At any rate it is of importance to the question of the interpretation of the quadrate bone in birds, that in the full-grown *Tachyglossus* there is a bone, consisting originally of three or four separate pieces, which effects an articular union of the *squama temporalis* with the *os pterygoideum* and (at an earlier period) with the lower jaw.

In *Ornithorhynchus*, in which the incus remains separate throughout life, the *os tympanicum* unites directly by the malleus with the *squama temporalis*; nevertheless it is to be observed that the incus situated above it is likewise united with the *squama temporalis*, which is the cause that, in this genus, it is difficult to remove the auditory ossicles in connexion.

Here, therefore, we see, in the Monotremata, that a bone composed of two or more pieces presents the same articular connexions as the *os quadratum* in birds, that by these pieces, through the *os tympanicum*, is effected the union with the *os pterygoideum* and the inner angular process of the lower jaw, whilst that with the *squama temporalis* is effected by the malleus and incus, or by the incus alone. The question still remains to be solved, in the young Monotremata, whether the long process of the malleus (occurring as a distinct bone, and, in part, representing a part of the *os tympanicum* of the higher Mammalia) at any time forms a condyle corresponding to the outer cavity of the articular process of the lower jaw in birds.—*Monatsber. Berl. Akad. der Wiss.* Dec. 5, 1867, pp. 779-781.

* To me the interpretation of this peculiar bone, which attaches itself like a scale upon the *squama temporalis*, given by Laurillard and Duvvernoy seems to be quite correct, although it is remarkable that it assists in the formation of the cranial cavity, which, indeed, induced Mr. Owen not to agree in this interpretation, without, however, giving a better one (Monotremata, *Cycl. of Anat. & Phys.* p. 7). I have been able to investigate this bone upon a very beautiful dissected skull, most kindly communicated to me by Professor Keferstein of Göttingen.

† That this small intermediate bone, which effects the articular union with the *squama temporalis*, is a portion of the incus was first made plain to me by a kind communication from my friend Flower, whom I induced to investigate this subject, and who wrote to me that he had found in a young skull of *Tachyglossus* the incus, which had previously been entirely overlooked, and which would only subsequently be amalgamated with the malleus, but was then distinctly to be recognized.

Leucodore calcaria.

To the Editors of the Annals and Magazine of Natural History.

GENTLEMEN,—Allow me to draw your attention, and that of your readers, to the figure of *Leucodore calcaria* appended to my paper last month. I have to apologize very greatly for its erroneous and sketchy appearance. The setæ are by no means correctly indicated, whilst the great branchial cirri, which curve over the back, are omitted altogether. This is owing to illness, which prevented me from seeing to the proofs of the plate. The figure given by Dr. Johnston originally, I believe, in this Magazine, and republished in the 'B. M. Catalogue of Worms,' is a very fair representation of his *Leucodore ciliata*, which I must refer to as a correction of the erroneous one in my plate. Since my paper did not deal with the morphological peculiarities of *Leucodore*, the figure was only of secondary importance.

I am, Gentlemen, truly yours,
E. RAY LANKESTER.

On the Growth of the Stem of Fontinalis antipyretica.

By Professor H. LEITGE.

The apical growth of this moss takes place by repeated divisions of a three-sided apical cell. The divisional walls are parallel to the lateral surfaces of the apical cell. The spiral of division is as often directed to the right as to the left. The segments cut off from the apical cell by the divisional walls are arranged, in accordance with their origin, in three longitudinal series, and at first incline towards each other at an angle of about 70°. Each segment is divided by a longitudinal wall into an outer and an inner part. The inner part of the segment, which subsequently becomes horizontal (the stem-part of the segment), displays in general the same development as the segments in the roots of many vascular Cryptogamia and in the stem of *Equisetum*. It is divided by the sextant-wall into sextants, in the larger of which an inner cell is cut off by a tangential wall. From the stem-part of the segment is formed the widely cellular, axile tissue of the stem.

The outer part of the segment (the leaf-part) partially retains its inclined position. It divides by a horizontal wall into the *acroscopic* and the *basiscopic basilar* portion. The former grows out into the free leaf-surface, a two-edged apical cell being formed in it. From the basiscopic basilar pieces the buds are developed. Hence each bud and the leaf standing above it belong to the same segment. One wall of the apical cell of the bud is always turned towards the apex of the parent shoot. The segmental spiral of the bud is always antidromous to the segmental spiral of the parent shoot. The tangential growth of the basiscopic basilar piece always remains much behind that of the acroscopic portion.—*Anzeiger der Akad. der Wiss. in Wien*, February 13, 1868, pp. 43–44.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 6. JUNE 1868.

XLVII.—On *Balanus armatus*, and a *Hybrid between this Species and Balanus improvisus*, var. *assimilis*, Darw. By Dr. FRITZ MÜLLER*.

[Plate XX.]

IN *Acasta purpurata*, which lives in the bark of an *Isis*, as also in *Acasta cyathus* and *sulcata*, which live in sponges, Darwin found that, in the outer branch of the fourth pair of cirri, the anterior margins of some of the inferior joints were armed with strong decurved teeth, by which means, he thought, these joints were converted into jaw-like structures, and became wonderfully well fitted to seize any prey (Darwin, '*Balanidæ*,' pp. 84 & 311). In no other Cirripede has a similar armature been hitherto detected.

When I first met with *Balanidæ* imbedded in a sponge, I of course at once looked for this armature, and had the gratification of finding both branches of one of the cirri equipped with similar but much more numerous teeth. But on closer examination it appeared, to my great astonishment, that in my species it was not the fourth, but the third pair that bore the teeth, and that the animal was not an *Acasta*, but a true *Balanus* with porous walls and a porous base, and scarcely distinguishable, as regarded its shell, from *Balanus trigonus*, Darwin.

Occurrence.—This *Balanus armatus* (as I have called it, on account of the abundant armature of its cirri) lives almost exclusively in sponges. I found the first three mutually adherent shells (two of them with the animal still in them) thrown up upon the shore, and rather worn. They appeared not to have been attached to a solid body; and in sheltered parts, especially beneath the deeply excavated base of one specimen, there was some loose sponge-mass, which, from the spicules,

* Translated by W. S. Dallas, F.L.S. &c., from Wiegmann's '*Archiv*,' 1867, pp. 329–356.

could be determined as belonging to a large sulphur-yellow *Papillina* not uncommon here. This *Papillina* (and perhaps, indeed, the whole genus *Papillina*, Schmidt), however, is nothing but a *Vioa* which takes up its abode in shells and other calcareous structures, penetrates them, and in course of time almost entirely destroys them, and, finally growing over them, increases into large cake-like masses, which may attain a diameter of more than a foot. It was therefore doubtful in this case whether the *Balanus* had sought out the Sponge, or the Sponge the *Balanus*, especially as the shells were attacked by the Sponge in several places.

Subsequently I have frequently found *Balanus armatus* in abundance in a *Reniera* which, in shape, colour, and form of spicules, closely approaches *R. aqueductus*, Schmidt, and is particularly characterized by its greatly developed fibrous framework, which is as readily washed out as that of the common sponge. Very rarely (I have as yet only once found three specimens) the *Balanus* occurs in one of our commonest sponges, which coats whole rock-walls in the form of a dark-red mass beset with steep, jagged, mountain-like protuberances, and in its hard structure approaches *Reniera digitata*, Schmidt. On the contrary, it is frequent on an eight-rayed polype, *Carijoa rupicola*, F. Müll.*, which grows at the depth of

* *Carijoa rupicola* (fig. 50). The entire stem of the polypary (which attains a height of 0.15 metre, rising straight or slightly curved, and is about 2 millim. in thickness, is formed by a single polype, which unfolds its tentacles at the extremity, and the body-cavity of which penetrates the whole stem. The polype can retract itself into the upper extremity of the stem. This retractile part is snow-white. The plumose tentacles are produced into a thin terminal filament, which appears nodose, like the slender lateral appendages. Beneath the circle of tentacles there are some delicate calcareous spicules. The dissepiments surrounding the stomachal tube are continued throughout the whole length of the hollow stem as eight slightly projecting longitudinal lines: two of these, lying close together, bear an undulated membranous border with a thickened margin, in which the dark brownish-violet ova are developed, likewise throughout the whole length of the stem. The wall of the stem below is sometimes as much as 0.5 millim. in thickness; above, it becomes thinner and flexible; in the lower part the stem appears smooth; in the upper, softer portion it is traversed by eight longitudinal furrows. There are no projecting calcareous spicules. The wall acquires firmness by closely approximated calcareous spicules, which are deposited in all possible directions in planes parallel to the axis. These are straight or slightly curved, irregularly beset with more or less numerous knots: some of them are longer (average 0.25, single ones more than 0.5 millim.), slenderer, and smoother than the rest; the others, which pass into the former by intermediate forms, are shorter and stouter, and beset with more numerous and stronger processes. The latter occur here and there fused together.

From the stem spring numerous branches, usually four or five, at nearly

about a fathom below the level of the water at midtide, on an isolated rock (not far from the shore at the south end of the Praia de Fora), and forms dense, slightly branched bushes of as much as 0·15 metre in height. The flesh-coloured stem of this polype, about 2 millims. in thickness, is usually coated by a dark-yellow sponge with pin-like siliceous spicules, forming a thin crust; and *Balanus armatus* is rarely absent from such sponge-coated polyparies: as many as ten or twelve are frequently seated, closely pressed together, upon such a polypary; and these are likewise covered by the sponge up to the opening.

On the same rock four other Balanidæ reside:—uppermost, above midwater, *Chthamalus stellatus*; at the lower limit of this species, and usually closely covered by it, *Tetrachita porosa*, especially on the seaward side; a little lower are seated some large shells of *Balanus tintinnabulum*; and then follows, extending down into the domain of the *Carijoa*, which is domiciled on the landward side of the rock, *Balanus improvisus*, var. *assimilis*. The latter occurs also in single specimens seated on the *Carijoa* and sometimes on *Balanus armatus*, or serving as a support for the latter. Once only I found a small *B. tintinnabulum*, only 8 millims. in height, upon the *Carijoa*.

Sometimes, but rather rarely, *B. armatus* is found attached to rocks. On one occasion I found two of its shells, in company with numerous specimens of *B. improvisus*, var. *assimilis*, upon a living *Purpura*. Lastly, I possess two specimens

the same level: the great majority of these remain short (about 4 millims. in length) and simple; but some become elongated, and again put forth lateral branchlets. The branches and branchlets perfectly resemble the stem in their structure. Each of them bears a polype at its extremity, and is traversed by its body-cavity. The body-cavities of the individual polypes which, as stem, branches, and branchlets, compose the polypary, are not connected with each other. From the lower extremity of the stem issue some thinner tubes, which act as roots, and, when applied to flat surfaces, are often flattened and dilated. Sometimes two neighbouring branches grow together superficially; this takes place more frequently in the roots. When exposed to the light, the dried polypary is very rapidly and completely bleached. Even in the fresh state, individual polyparies are almost colourless; but others are, on the contrary, much darker than is shown in the figure. The name *Carijoa* is derived from that of the inhabitants of our island (Santa Catharina) at the time of its discovery by Europeans,—the Carijós.

Besides the yellow coat [mentioned in the text], four or five species of *Reniera* are found, but not very frequently, adhering to the *Carijoa*; these are of a dark-red, pale-violet, greenish-grey, or snow-white colour; and one can imagine nothing of a gayer appearance than a bush of *Carijoa* such as I have seen, traversed and enveloped by all these sponges at the same time.

which are seated close together upon the tube of a *Serpula* (*Eupomatus floribundus*, F. Müll.), which bears, close to them, two shells of *B. improvisus*, var. *assimilis*. This, which is the commonest of all the Balanidæ here, sometimes even occurs in *Reniera* as the companion of *B. armatus*.

General appearance.—The shell of *Balanus armatus* (fig. 1), as regards form and colour, is very variable in its general appearance. For the most part, in this, as in other species, this difference is caused by the support upon which the animal has domiciled itself. Hence the most regular shells are generally those imbedded in soft sponges, the development of which never meets with any obstacles. They are usually found here of a steeply conical form sometimes nearly cylindrical, the longitudinal diameter (from the rostrum to the carina) generally rather greater than the transverse, the rostrum and carina nearly of equal height, the base *always* concave, and generally in a high degree. In this respect, therefore, *B. armatus* agrees with the allied *B. spongicola*, and differs, like the latter, from the sponge-haunting *Acasta*, in which the base is strongly convex. But even in *Reniera* very divergent forms are not wanting. I have seen shells in which the rostrum was only half as high, and others in which it was twice as high, as the carina.

The form of the shells seated upon the *Caryjoa* is particularly variable. It differs according as they are attached longitudinally, or transversely, or obliquely to the stem of the polype, which usually forms a deep furrow in their base. This is elongated in the direction of the furrow, which, again, has an influence upon the whole shell, so that even in its middle the breadth varies from two-thirds to four-thirds of the length. Not unfrequently the separate pieces of the shell are of very different heights, all the pieces of one side being sometimes twice as high as those of the other. Rarely the furrow of the base is closed, so as to form a complete tube. On one occasion I found *Balanus armatus* adhering to the apex of a branchlet; and in this case the base formed a conical tube round the branchlet, longer than half the height of the shell; the diameter of the base was only half the length of the orifice. In other cases, again, the base is more than twice as long as the orifice. Shells inflated in the middle also occur. A particularly remarkable form was seated transversely upon the stem of a *Caryjoa*. The rostrum and carina are unusually broad, almost equilaterally triangular; they embrace the stem and meet together beneath it upon one side in a sharp edge. The walls of the lateral and carino-lateral pieces, on the contrary, are quite narrow strips. But it would be necessary to figure

hundreds upon hundreds of different forms to exhaust the varieties of these *Balani* seated upon *Carijoa*; nevertheless in these, and likewise in the shells seated upon rocks, a steeply conical form predominates. The two shells observed upon *Purpura* were flatter than usual; their walls were less steep, and their base larger in proportion to the orifice.

The surface of the walls is usually smooth, rarely furnished with inconsiderable longitudinal ribs; the shells attached to rocks generally have stronger ribs. The colour of the walls is sometimes quite pale; sometimes they are striped with a lighter or darker dingy brownish purple. The radii usually exhibit a more or less distinct dingy purple colour. Not unfrequently there is a remarkable difference of colour between the two sides of the same shell; and if we may imagine that the influence of light has something to do with this, this explanation is not applicable to a group of three shells of which the lowest and largest is unusually dark-coloured, the second, sitting upon this, is almost white, and the third and youngest, which adheres to the second, has particularly distinct whitish ribs, and between these pale-brown streaks. The sheath is pale; the opercular pieces partly pale, partly dark, but usually reddish, at least towards the apex.

I never found the epidermis preserved upon the radii, and rarely in traces upon the lower part of the walls; but I possess an example from a *Reniera* the walls of which are still completely covered with a yellowish membrane, and the radii of which are, moreover, distinguished by their white colour.

But, different as the shells of *Balanus armatus* may be in their form and colouring, they all agree completely in the peculiar form of the mouth, which reminds one of that of *B. trigonus*, though, unlike that of the latter species, it is always distinctly toothed*. The radii are always oblique, especially those of the rostrum; their free margins usually form with the wall of the rostrum an angle a little under, and with that of the lateral piece a little over 60°, meeting the alæ of the lateral piece about in the middle. In like manner the margins of the radii of the lateral piece and of the alæ of the carino-lateral piece meet each other about in the middle, whilst the margins of the alæ of the carina only meet the radii of the carino-lateral pieces close to the walls of the latter. Like the denticulation of the orifice, we find, as a second peculiarity in all well-preserved shells, that the rostrum is a little bent inwards at the orifice.

* The sole exception (and this is probably only apparent) is furnished by the three shells which I found thrown up on the shore. Their mouths are entire and toothless; but I believe that they only lost their teeth during their rolling in the sea and surf.

If the orifice be looked at from above, its denticulation is not apparent, and we then see, taking the greatest breadth of the orifice as a base, on one side an isosceles triangle, the apex of which, with an angle of 50° – 54° , is formed by the carina, and on the other a low trapezium, the smaller base of which is slightly curved inwards and formed by the radii of the rostrum up to their crossing-points with the alæ of the lateral pieces. The sides of the triangle reach from the apex of the carina nearly to the points of the lateral pieces; the height of the trapezium is about one-fourth of that of the triangle; and the height of the triangle is about equal to its base, the greatest width of the orifice.

Pentagonal orifices, formed by a triangle and a trapezium having the greatest breadth of the orifice for their common base, occur elsewhere among the *Balani*, as, for example, in *B. improvisus*, var. *assimilis*; but the lowness of the trapezium in *B. armatus* is peculiar. In *B. trigonus* it becomes still lower, and, indeed, nearly disappears; so that here the orifice appears like an equilateral triangle with two slightly truncated angles. If a line be drawn through the apices of the carina and rostrum parallel to the straight lines passing through the apices of the lateral pieces, or, to express it rather practically than mathematically, if a line be drawn in the direction indicated upon the apices of the carina and rostrum, we find that the apices of the carino-lateral pieces do not quite reach this line, and that those of the lateral pieces are still more distant from it. It is remarkable how very rarely, and in how small a degree, the regularity of the orifice is affected by the greatest irregularities of the shell.

Size.—In the Sponge allied to *Reniera aqueductus* I found only small shells, the diameter of the base and height of which rarely attained 8 millims.; they grow larger on the *Carijoa* and on rocks; and the largest that I have seen are the three from *Papillina*. Here follow some measurements:—

	I.	II.	III.	IV.	V.	VI.	VII.
Length of base ..	6	7.3	11.3	8.3	20	14	6.2
Breadth of base ..	5	6.8	9.3	6.9	14	16	6.2
Length of orifice	3.6	5.1	6.9	5	6	6	2.6
Breadth of orifice	2.8	3.8	5.5	4	5.4	5	2
Height of rostrum	5.5	8.1	9.7	7.7	17	5	4
Height of carina	5.5	9.1	11	8.5	4	12.4	2.8

I. Mean of eight measurements; shells from *Reniera*.

II. Mean of five measurements; shells seated on *Carijoa*.

III. Mean of five measurements; shells adhering to rocks.

IV. Mean of twenty measurements, in which the preceding eighteen are included.

v. & VI. Two of the shells from the *Papillina* seated on the third empty shell; v. has the carina, and VI. the rostrum turned towards the orifice of the subjacent shell: in the former the rostrum is more than four times as long as the carina, in the latter the carina nearly three times as long as the rostrum; but the planes of the orifices of all these shells are nearly parallel.

VII. Shell seated on a *Purpura*.

Scuta.—The scuta are very narrow; the occludent margin is nearly or fully twice as long as the basal margin; the tergal margin is a little shorter than the occludent margin. The apex is usually slightly curved upwards; the outer surface is covered with strongly projecting lines of growth, and with from one to six longitudinal rows of pits, which are generally very deep, and frequently of considerable width (fig. 2). In twenty-eight animals taken at random, there were in the lower part of the scuta:—once, two on each side; eight times, three; eight times, four; once five, and once six rows; further, six times, three rows upon one scutum and four on the other; twice, four on one side and five on the other; and, lastly, once, five on one side and six on the other. A single row of pits was seen by me only on the two animals adhering to *Purpura*. In the inside of the scutum there is an articular ridge, not of great breadth, which reaches beyond the middle, or even to the lower third of the scutum, and terminates there in a rounded end or in a small point. The adductor ridge is inconsiderable, and extends scarcely further downwards than the articular ridge. Sometimes there is a very fine, sharp longitudinal ridge between the articular and adductor ridges. For the musculus depressor lateralis there exists a pit which is usually narrow and deep. In the larger animals especially the scuta are often of remarkable thickness.

Terga.—These agree perfectly with the descriptions given by Darwin of *Balanus trigonus*. The six to seven ridges for the musculus depressor* never extend beyond the basal mar-

* Darwin's statements as to the action of the three pairs of muscles which descend from the operculum towards the base of the shell appear to me, from what I have observed, especially in *Tetrachita porosa*, not to be quite correct. According to Darwin, the operculum is opened by the depressores acuti laterales; sudden contractions of the depressores rostrales probably cause the strokes which the animal gives with the beak-like apices of the terga; by the common contraction of the three pairs the operculum is held down with surprising force; the operculum can only be raised by the pressure of the body against the base. (Darwin, 'Balanidae,' p. 62.)

If we attempt to cut the operculum of *Tetrachita porosa* out of the shell, the knife will find a free passage everywhere except in two opposite

gin of the tergum. The rows of bristles upon the lines of growth of the opercular pieces are more strongly developed in *Balanus armatus*, especially upon the scutum, than in the few other species which I have been able to compare with it. They are short and delicate upon the carinal side, and 0·2 millim. or more in length, and delicate, upon the scutal side of the tergum, of the same length, but far thicker and closely packed, upon the scutum. Longer and shorter bristles alternate, but not as two clearly different forms, as is the case in *B. improvisus*, var. *assimilis*. The chitinous cords (tubuli, Darw.) which, proceeding from the bristles, permeate the opercular pieces in an undulating course, become rapidly diminished into delicate filaments, which may easily be extracted from the surrounding mass by breaking up the opercular pieces when deprived of lime by acids (figs. 14–16)*.

points in the neighbourhood of the spurs. Here the operculum is closely applied to the sheath; the membrane which unites the base of the operculum with the sheath is here narrower and firmer than elsewhere. Thus these two points form an axis (which is certainly somewhat displaceable) round which the operculum can turn. We may now, in fresh animals, readily seize the individual muscles and pull them, so as to arrive at an explanation of their action. As might be expected from the mode of attachment of the operculum, the carinal margin of the tergum is drawn down by the depressores tergi, whilst, on the contrary, the rostral angle of the scutum is elevated and the occludent margin acquires an almost horizontal position. These muscles *alone* effect the powerful holding-down of the closed operculum; the latter is then supported by the carinal margins of the terga against the sheath, which at this point usually shows more or less distinct traces of wearing. By the depressores scuti, both laterales and rostrales, the bases of the scuta are drawn down, and the carinal margins of the terga elevated, whilst the occludent margin attains a more or less upright position. Because its apex projects further, the entire operculum then appears elevated; this, however, is only apparent, and this elevation of the apex may be produced by pressing from without upon the rostral angle of the scuta, instead of pulling from within upon the depressores scuti. Elevation and sinking of the entire operculum, however, takes place, only to a rather limited extent; how far a pressure of the body against the base assists in it, I will leave undecided.

The opening of the operculum is brought about, I believe, only by the pressure of the animal against the opercular fissure; the depressores laterales cannot open it. As may be easily ascertained from opercula which have been removed with their connecting membrane, the two halves of the operculum, in opening and closing, turn upon an axis passing through the rostral angle of the scuta and the carinal angle of the terga; whatever is situated above this axis departs during the opening from the median line, and whatever lies beneath it approaches this line. But the depressores scuti laterales pass from points beneath the turning axis downwards and somewhat outwards, and therefore cannot possibly approximate their points of insertion to the median line, as would be necessary for the opening of the operculum.

* In *Tetrachita porosa*, in which the chitinous cords remain tolerably thick to the end, I have seen a pale filament projecting from their extre-

The compartments of the Shell.—The tubes which penetrate the walls are tolerably wide; in the uppermost part they are completely filled, without transverse septa. The inner surface of the walls is ribbed longitudinally, usually throughout, but sometimes only below. The *radii* are externally smooth and shining, with a fine striation in two directions, the one parallel to the septa, the other to the sutural edge. The former is always more distinct; it is not caused by prominence of the septa. In the *radii* of the rostrum and of the lateral pieces this striation is nearly perpendicular to the walls of the lateral pieces; in the *radii* of the carino-lateral pieces it is perpendicular to the wall of these pieces. Within, the *radii*, where they do not lie upon the *alæ*, are often finely ribbed by the projecting septa; these ribs are generally very distinct, but sometimes scarcely perceptible, and sometimes the *radii* are quite smooth internally. In the septa of the *radii*, the interstices of which are closely filled up to the suture, but often distinguished by their reddish colour from the white septa, I have been unable to detect any distinct denticulation. The sutures of the *alæ* are smooth. The sheath has a sharp edge projecting freely below.

Base.—The base is porous; only in very rare cases it projects beyond the lower margin of the shell. Even in the animals domiciled in sponges the cement-tubes are well developed, whilst in *Acasta* they were not detected by Darwin. After the base has been treated with acids, they appear as colourless empty tubes. Their ramification differs in different animals, but is exactly the same in the different older and younger tubes of the same animal, so that the branches of each younger circle run parallel to those of the older inner ones. Not unfrequently cæcal diverticula occur. At the margin of the base, which is rarely got under the microscope in a good state of preservation, I have seen the cement-tubes dividing into very fine reticulated branchlets, such as Darwin describes and figures in *Balanus tintinnabulum* (Balanidæ, pl. 28. fig. 4 a).

Mouth.—The *upper lip* (fig. 10) has three approximated teeth on each side of the central notch. The *mandibles* have four distinct teeth; the fifth is sometimes entirely deficient, but is usually to be distinguished as a small tubercle above the lower angle of the mandible. On one occasion I found in the same animal the fifth tooth uncommonly distinctly developed on one side, whilst on the other it was en-

imity, as though a nerve entered the cord; between the bristles and the chitinous cords there seems to be a sort of articulation.

tirely wanting. The *maxillæ* have a straight margin, with a very minute notch below the uppermost setæ, or without any such notch. There is no projection for the lower bristles. The upper and the two lowest setæ are only a little longer than the longest of the middle ones. Only about one-third of the upper margin of the *maxillæ* is hairy.

Cirri.—First pair: the longer branch is about twice as long as the shorter one, sometimes still longer, and has twice as many joints (eighteen to twenty); the last joints are considerably longer than the lower ones, cylindrical, and beset at the end with an almost complete circlet of setæ. The shorter branch has usually from nine to eleven short joints, with densely setiferous processes on the bowed side, most considerable on the middle joints.

Second pair short, stout, densely bristled; the anterior or outer branch with from eleven to thirteen joints, only about one-fifth or one-fourth longer than the inner one; the latter is 9–10-jointed, and about as long as the shorter branch of the first pair. In cast skins, and also usually in other cases, the longer branch is seen straightly extended, and the shorter one slightly curved.

Third pair: from the base of this pair of feet a line densely beset with long thin hairs runs upwards towards the back. In length and form this pair hold a middle place between the short and stout cirri of the preceding and the long slender cirri of the following pairs. The slightly longer anterior or outer branch has about fifteen to seventeen joints, the hinder branch one or two fewer. The branches are about as long as the longer branch of the first pair. A larger or smaller number of the joints of both branches are armed on the curved side with strong curved teeth: in young animals the armature is weaker and confined to some of the middle joints; in the larger animals, only the last two joints of the outer and the last four or five joints of the inner branch usually want the teeth. The armature of the outer branch is always stronger than that of the inner one. These hooked decurved teeth (fig. 21) not only occupy the upper part of the strongly prominent margin of the flexed side of the joints, but extend thence, gradually becoming smaller, and finally converted into mere minute points over a larger or smaller part of the outer surface of the joints. This portion which is beset with teeth and hooks is usually elevated, in the form of a low swelling, a little above the surrounding parts. Besides the teeth of the flexed side, there are, especially on the lower joints, acute spinules directed upwards on the extended side, a few spines, also directed upwards, on the outside of the upper margin, and

frequently, at the same place, several groups of very delicate points.

The middle joints of the outer branch also bear, within the toothed armature, from two to four pairs of setæ; with these are sooner or later associated at first a single, and afterwards several rows of setæ on the inner margin of the upper end of the joints, and finally, on the last joints, a dense irregular coat of setæ which often covers a great part of the inner surface. On the inner branch the setæ of the inner surface are more numerous, even on the lower joints.

Fourth to sixth pairs: the cirri of the last three pairs of feet are rarely all found uninjured; sometimes one, sometimes another of them wants a larger or smaller piece. These losses, as is well known, are more or less completely replaced by the formation, in the last of the remaining joints, of a number of new joints, which come into use after the next change of skin. The frequency of such mutilations scarcely allows us to say anything as to the number of joints in these cirri. In the last pairs this may exceed forty-five, and their length is often more than three times that of the third pair. The joints of all these cirri are thinner, but much longer, than those of the anterior pairs; the upper joints almost always bear on the flexed side four pairs of setæ, but frequently only three in the fourth pair of feet.

In the fourth pair the dorsal surface of the first joint of the outer branch is usually armed with rather strong denticles directed upwards; on the middle joints of both branches, but especially the outer one, besides the short pointed spines, and in their vicinity, more or less numerous spines directed upwards are scattered over the outer surface of the joint; in rare instances these spines become converted, on the outer branch, into slightly curved teeth directed downwards, so as to produce an armature similar to that of the third pair, although certainly weaker (fig. 22).

The fifth pair of feet is distinguished by a strong, somewhat curved tooth, directed upwards, which stands at the commencement of the dorsal surface of the second peduncular joint; this is usually followed by a similar smaller tooth, or more rarely by two. These are seldom altogether wanting.

On the sixth pair of feet the peduncular joints and the first joints of the cirri have their dorsal surface covered with very numerous, short, close-sitting points, directed upwards.

Penis.—At the base of the penis, between it and the anus, the usual conical process exists; the penis, which is extensible to several times the length of the cirri, is beset only with a few short hairs.

Ova.—0·17 millim. long, 0·09 millim. thick. In the *larvæ* I find nothing remarkable; they are very like those of *Tetraclista porosa*.

Affinities.—The nearest ally of *Balanus armatus* is *B. trigonus*. Indeed, whether the former might not better be regarded as a mere variety, and indicated as *B. trigonus*, var. *armatus*, can only be decided by comparison with numerous examples of *B. trigonus* from various localities. But it may be cited, in favour of its specific title, that *B. trigonus* has hitherto been found only in the Indian and Pacific Oceans, and not in the Atlantic, and only on the shells of mollusca and on wood, but not in sponges—that in *B. trigonus* the shell is usually shallow and ribbed, and the mouth has entire margins and is almost equal-sided, whilst in *B. armatus* the shell is usually abruptly conical and smooth, and the mouth always distinctly toothed and pentagonal—that the scuta are narrower in *B. armatus*—and that the armature of the third pair of feet, which was never missed in *B. armatus*, and indeed caught the eye at the first glance, is not mentioned by Darwin in *B. trigonus*, any more than the strong tooth on the peduncle of the fifth pair, which is *always* present in *B. armatus*.

The shells seated upon *Carijoa*, when predominantly developed in length, and especially when the base somewhat projects, sometimes resemble in general appearance the species living on Gorgoniæ, which, in Darwin's work, form the section B of the genus *Balanus*; but this resemblance is merely the consequence of the similar mode of adhesion, and scarcely the sign of any near affinity. In other respects Darwin's remarks upon the affinities of *B. trigonus* apply to our species.

Signification of the armature of the cirri.—A similar armature of the cirri with spines and points, although not so strongly developed, occurs in other *Balani*. In individual examples of *B. improvisus*, var. *assimilis*, these spines, elsewhere directed upwards, even occur directed downwards and backwards, as in *B. armatus*, on the outside of the joints of the third and fourth pairs of feet. This armature of spines and points occurs almost exclusively on the surfaces turned towards the margin of the opercular fissure, as on the outer surface of the middle pairs and on the dorsal surface of the last pair. In this position they cannot serve for the seizure of any prey, but scarcely for any other purpose than the cleansing of the fissure. In fact, in living animals, we see that the cirri of the third and fourth pairs, the outer surface of which is particularly richly spinous, are those which pass closely along the margin of the opercular fissure during their protrusion and retraction.

Now, that it is exactly in spongiolar species, otherwise by

no means nearly related, that this armature is developed into large curved teeth, intimates that there is a connexion between the peculiar armature and the peculiar domicile; and it is not a far-fetched supposition that the teeth serve to tear in pieces and remove the rapidly growing sponge-mass which threatens to grow over the aperture of the shell. It is a remarkable circumstance that in *Acasta* the teeth stand on the outer branches of the fourth, and in *B. armatus* on the branches of the third pair of feet. This circumstance might be adduced in favour of the Darwinian view of the origin of species, in the same way as the different structure of the posterior entrance to the branchial cavity in the different air-breathing crabs*. *Balanus armatus* is much more nearly allied to other, not spongicolar *Balani* than to *Acasta*; *B. armatus* and *spongicola* on the one hand, and the species of *Acasta* on the other, cannot consequently have inherited the habit of domiciling themselves in sponges from a common ancestor. Contrivances which stand in relation to this peculiar dwelling-place must therefore have been produced independently in each case; and therefore it cannot appear strange that we find them developed on different parts of the body in *Balanus armatus* and in *Acasta*.

II.

Until recently the *Balani* passed universally as self-impregnating hermaphrodites. But that self-impregnation does not take place in all cases was proved by a remarkable observation of Darwin's, who found the penis rudimentary and imperforate in several individuals of *Balanus balanoides*, although there were well-developed larvæ in their shells (*Balanidæ*, p. 101). To me it has long been doubtful whether self-impregnation is really the general rule. For what purpose should the length of the penis be often three times the diameter of the shell, if it has nothing to seek outside the latter? Some observations which I have recently made have confirmed me in this doubt.

It is well known that the *Balani* are very sensitive to light†, so that they immediately retract their cirri and close the oper-

* Fritz Müller, 'Für Darwin,' p. 20.

† The sensitiveness of the *Balani* to luminous impressions is not dependent on the eyes discovered by Leidy. I had taken a large *Balanus tintinnabulum* living out of its shell, and separated it from the operculum, with which the eyes remained in connexion. It lay in a saucer of water, with its cirri half unrolled. As often as the shadow of the hand fell upon it, it rolled up the cirri with a sudden movement. In *B. tintinnabulum* the eyes are very distinct: in *B. armatus* I have not yet found them; and this is not due to the smaller size of the latter species, as they are very easy to detect even in small specimens of *B. tintinnabulum*.

culum when the hand, for example, is passed between them and the window.

It is remarkable that individual animals are much shyer, and others, again, bolder than the rest—that the former always remain longer closed, and the latter venture out more quickly, and even become accustomed to the passage of the hand at regular intervals. I may remark, in passing, that I detected similar mental differences between the animals of a group of *Eupomatus floribundus*.

Once when, in repeating these observations, I was watching the action of the cirri in some examples of *Balanus armatus* which I had taken freshly from *Carijoa* and cleaned from their coating of sponge, I saw that one of them suddenly ceased striking with its cirri, held them for some seconds immoveable and widely spread out, and during this period the penis extended to its utmost length and moved about as if feeling or seeking for something. I then no more disturbed my animals with the shadow of my hand, in order, if possible, to see this spectacle repeated; and in fact I soon witnessed the same phenomenon again, not only in the same animal, but also in three or four others. I now placed these ardent animals close together, in order to facilitate their reciprocal copulation; but as often as the elongated penis came within reach of the cirri of a neighbour, it was pushed to and fro by them, and the animal did not remain quiet so as to give access to it. Upon this I examined two of the animals, and found the entire canal of the penis densely filled with semen; but in both there were also ova which had already completed their segmentation, and consequently no longer required fecundation. With the penis so filled, when extended to its utmost length, semen must certainly have been expelled from it (which I could not have seen upon a white saucer); but at the same time, from the length of the penis, usually extended in a lateral direction, this semen would be removed from the vortex produced by the cirri of the same animal and placed within reach of neighbouring animals which might require it. It is remarkable that, although at that time I made the observation upon four or five animals simultaneously, I have been unable to repeat it, notwithstanding that I have repeatedly looked for it in numerous fresh animals.

The second observation which seems to prove that fecundation sometimes occurs even between different species of *Balanus* is as follows:—Among the *Balani* obtained on *Carijoa*, which I had at the first glance determined as *B. improvisus*, var. *assimilis*, there was one that struck me by a somewhat reddish coloration, such as I had never seen in this infinitely

abundant species. On examining it more closely, I found, instead of the narrow radii covered with a yellowish membrane of *B. assimilis*, the well-developed shining radii of *B. armatus* with their peculiar striation. At the same time, however, the form of the mouth, the appearance of the scuta, and the walls, with their translucent streaks and the septa of their tubes rendered doubly distinct by the reddish coloration, were exactly as in *B. assimilis*. Amongst hundreds of *B. armatus*, I had never seen anything like these walls, aperture, and scuta, nor amongst countless thousands of *B. assimilis* any radii at all similar; and I could not help in all seriousness asking myself the question whether I had not before me a hybrid between the two species the peculiarities of which were here so wonderfully united. I have subsequently met with three of these supposed hybrids: two of these were seated, like the first, immediately upon the *Carijoa*, and the third upon a *B. assimilis*; on the other hand, a *B. assimilis* was seated upon one of the others. A close examination of these four animals gave the following results:—

General appearance.—In the form of the distinctly toothed aperture, the greatest breadth of which is nearly in the middle between the carina and the rostrum, in the translucent striæ of the smooth walls, and in the peculiar curvature of their walls, which it is difficult to reproduce in words, all the four animals resembled *B. assimilis*; in the formation of the radii, except that the margin runs somewhat more obliquely, *B. armatus*. The colour in one was somewhat reddish, in the others nearly white, yellowish at the lower part of the shell in two of them. Accidentally, in consequence of their mode of attachment, the base in all was much longer than broad, and the rostrum higher, in one more than twice as high as the carina.

Size.—Mean of the measurements of the four shells:—length of base 7·1 millims., its breadth 3·7 millims.; length of the aperture 4·3 millims., its breadth 3·4 millims.; height of rostrum 8 millims., of the carina 4·4 millims.

Scuta.—The basal margin of the scuta is more than three-fourths of the length of the occludent margin, and is even longer than the tergal margin; on the outer surface, which shows no trace of pits or longitudinal striæ, the striæ of growth only project moderately; on the inner surface there is a strong adductor ridge, which is amalgamated with the articular ridge above, and may be traced below nearly to the basal margin. The pit for the depressor lateralis is shallower and more roundish than is usual in *B. armatus*.

Terga.—The terga, like the scuta, are far more similar to

those of *B. assimilis* than to those of *B. armatus*, hardly differing from the former, except in a somewhat broader spur. They are broader than in *B. armatus*; the spur, which does not occupy one-third of the breadth of the base, is distant almost its own breadth from the scutal margin; a shallow longitudinal channel occupies nearly the whole breadth of the spur. The ridges for the depressor carinalis are very strongly developed, and project beyond the basal margin.

I was particularly curious as to the hairiness of the opercular pieces, as in this respect *B. armatus* and *assimilis* differ greatly from each other. In *B. armatus* there are short delicate hairs upon the carinal side, and long slender hairs upon the scutal side of the terga, and long, strong, closely approximated hairs upon the scuta; in *B. assimilis* there are everywhere short thick spines alternating with every one to three of the longer delicate hairs. I was surprised at finding in the supposed hybrid neither the one nor the other, nor an intermediate structure. On the terga there stood, on each side of the hairless furrow, rather long and delicate hairs; on the scuta the hairs were shorter, but neither thicker nor closer together. I may remark that I examined these hairs only in one animal.

Pieces of the shell.—The pieces of the shell, which in *B. assimilis* may be readily separated even in the living animal, adhered firmly together in the single animal in which I separated them, even after boiling in solution of potash. The walls, of which I have already stated that their tolerably wide tubes have numerous septa in their upper part, are longitudinally ribbed within throughout their length. The freely prominent lower margin of the sheath is narrower than in *B. armatus*, but more strongly developed than in *B. assimilis*.

Parts of the mouth.—In one animal the *labrum* exactly resembled that of *B. armatus*; in the others also it had only three teeth on each side; but in two of them the outer tooth was widely separated from the others, and in the fourth the two outer teeth were brought close together, and somewhat distant from the inner one. Neither of these structures has occurred to me in *B. armatus*; but the former is frequent in *B. assimilis*. Of the numerous denticulations with which the margins of the median notch are beset in *B. assimilis* there was nothing to be seen.

The *mandibles* might be equally well regarded as belonging to a *B. armatus* as to a *B. assimilis*, as they do not notably differ in these two species.

In the *maxillæ* of all four animals the median setæ were shorter than in *B. armatus*, and longer than is usual in *B. as-*

similis; as in the latter species more than half the upper margin was clothed with hair.

Cirri.—First pair: the longer, 19–22-jointed branch was in three animals about twice as long as the shorter one, in the fourth about one-fourth longer; the shorter branch in two animals had fourteen joints (in the others eleven and thirteen). I have not met with so great a number of joints in *B. armatus*; in *B. assimilis* it is frequently still greater (fifteen to eighteen). In the latter species, as is well known, the two branches are generally of almost equal length; nevertheless, even in this, I have observed a difference of nine joints (fifteen and twenty-four).

Second pair: thirteen to sixteen joints in the outer, twelve to thirteen in the inner branch; in *B. armatus*, eleven to thirteen in the former, nine to ten in the latter; in a *B. assimilis* which I have at hand I count seventeen and sixteen.

Third pair: in three animals I found in the outer branch thirteen to sixteen, in the inner twelve to fourteen joints; the fourth had on one side thirteen and twelve, and on the other twenty-one and twenty joints! The bristling and armature of this pair of feet were in all four animals the same as in *B. assimilis*; the setæ on the inner surface of the joints were very numerous; and on the outside there were only straight spines and points, chiefly directed upwards.

Fourth to sixth pairs: the flexural side of the upper joints in the fifth and sixth pairs of cirri in all four, and in the fourth in three animals, bore five pairs of setæ; the fourth animal had only four pairs of setæ on the joints of the fourth pair of feet. In *B. assimilis* six is the usual number of pairs of setæ on the joints of the posterior cirri. The outer surface of the joints in the fourth was armed in the same way as in the third. No trace of the strong tooth which in *B. armatus* stands on the peduncle of the fifth pair was to be found in any of the four animals.

Penis as in *B. armatus*. In *B. assimilis* this organ is generally beset with longer and more numerous hairs.

Affinities.—The discovery just described seems to me to admit no other supposition than that the four animals are really hybrids of *B. armatus* and *B. assimilis*. If we do not choose to let them pass as such, we must either regard them as a variety of *B. armatus* or of *B. assimilis*, or as a distinct species.

But in *B. armatus* the walls never have translucent longitudinal lines, or transverse septa in the tubes which run through them; the greatest breadth of the aperture never falls nearly

in the middle between the carina and the rostrum; the scuta are always considerably narrower; the rows of pits on the outer surface are never wanting; nor on the inner surface are adductor ridges, traceable nearly to the basal margin, to be seen; the terga never have such narrow spurs, or a longitudinal furrow, or ridges for the musc. depressor projecting beyond the basal margin; the strong curved teeth on the cirri of the third pair and the strong tooth on the peduncle of the fifth pair are never wanting; there are never more than four pairs of setæ on the posterior cirri, &c.

In *B. assimilis*, on the contrary (a species so common here that every potsherd, shoe-sole, or rope's-end which has lain for some time in the sea is covered with it), I have never seen a similar reddish colour to that presented by one of the supposed hybrids; I always found the radii quite narrow, covered with a thin membrane, never broad and shining; I always found short spines between the hairs of the opercular pieces, and the spur narrower, the labrum always beset with numerous teeth; and in the animals which I have to-day examined for this purpose, but which, indeed, are not very numerous, I found constantly six pairs of setæ upon some joints of the posterior cirri, not to mention other small distinctions.

It is evident that the differences from either species are too considerable for a mere variety; they would be of sufficient importance to lead us to regard our animal as a distinct species, if there were not other considerations opposed to this view. Species of *Balani*, where once they occur, do not usually appear so isolatedly that in the course of a month only four specimens can be brought together*. And how surprising would it be that upon the stem of *Carijoa* a third species should be domiciled amongst *B. armatus* and *assimilis*, standing in so peculiar a manner in the middle between the two species as do our animals, which agree with *B. armatus* in almost everything by which they differ from *B. assimilis* (in the coloration of one of the shells, in the firm union of their pieces, in the structure of the shining striated radii, in the structure of the labrum), and which in almost everything by which they differ from *B. armatus* (in the formation of the walls, the aperture, the opercular pieces, &c.) agree with *B. assimilis*, and, again, in other respects (as in the number of

* I cannot say exactly among what number of *B. armatus* the four hybrids were found, as I have used up a great quantity of the former without counting them; the number may be about 400. For a month or more I have daily dived upon the *Carijoa* rock whenever the sea was sufficiently quiet, and not unfrequently obtained from thirty to forty *Balani* at once upon the polytypes brought up.

pairs of setæ on the posterior cirri), stand exactly in the middle between the two species.

From all this, it seems to me to be the simplest and most natural course to explain the astonishing mixture of the characters of *B. armatus* and *B. assimilis* which our animals show, by a true intermixture, and therefore to regard them as hybrids of the two species.

But why, it will be asked, if this supposition be correct, are not hybrids of *Balani* remarkably abundant, if they occur at all? The different species so commonly dwell intermixed with each other, that three or more species may not unfrequently be found united in the same group. To this I can only answer with suppositions. In order to obtain hybrids of plants, the stigma must be carefully protected from the pollen of the same species. If pollen of the same and of another species be placed upon the stigma at the same time, the latter remains inactive. In the same way, in animals, if the semen of the same and of another species be simultaneously in contact with the ovum, the latter may remain inactive. Now, wherever species of *Balanus* reside together in abundance, the ova will never miss the semen of their own species, and therefore no production of hybrids will take place. This can only occur when the ova of one animal come in contact only with the semen of a different species. Now this might easily be the case in an isolated *B. assimilis* which had wandered into a tuft of *Carijoa*, and here, deeply hidden, was surrounded only by *B. armatus*. If this explanation be correct, our hybrids would be produced from ova of *B. assimilis* fertilized by semen of *B. armatus*.

A further question raised by these hybrids is, why they have received from *B. assimilis* precisely the formation of the walls, opercular pieces, cirri, &c., and from *B. armatus* the precise structure of the radii, labrum, &c. It may be said that the merely transversely striated scuta and the weakly armed cirri of *B. assimilis*, and the broad smooth radii and sexdentate labrum of *B. armatus*, differ less from the ordinary characters of the genus than the deeply pitted scuta and the strong teeth on the cirri of *B. armatus*, or the narrow radii clothed with membrane and the 22-28-toothed labrum of *B. assimilis*. This applies also to the uniformity of the hairy covering of the opercular pieces. But by this means the matter of fact is only brought under a general point of view, and not explained. Out of this difficulty in this case, as usual, we can hardly escape without Darwin's theory of the origin of species. But if we regard the species of a genus as descendants of a common primitive form, and at the same time, in accordance with the well-known experience of gar-

deners, regard their various peculiarities as so much better fixed, or so much less variable, the earlier they were acquired, the longer they have been inherited unchanged, it becomes intelligible that, above all, the characters proper to the primitive form persist, and that consequently, in the crossing of two species, these are more readily transferred to the hybrid than later-acquired peculiarities of the father or mother.

From this point of view I think we shall be able to explain many peculiarities of hybrids and, *vice versâ*, perhaps in many cases to trace from the form of the hybrids to the primitive form of the genus,—the latter, of course, only with the greatest care; for the mere fact that the hybrids produced by males of one species with females of another do not agree with those produced by males of the second species with females of the first, furnishes a proof that other circumstances aid in determining the form of the hybrids.

EXPLANATION OF PLATE XX.

- Fig. 1. Specimens of *Balanus armatus*, seated upon *Carijoa*: *c*, carina; *r*, rostrum.
 Fig. 2. Scutum of *B. armatus*, seen from without, with particularly large pits and distant striae of growth.
 Fig. 3. Another (remarkably broad) scutum, from within.
 Fig. 4. Hybrid of *Balanus armatus* and *B. improvidus*.
 Fig. 5. Scutum of *B. improvidus*, var. *assimilis*, from without.
 Fig. 6. The same scutum, from within.
 Fig. 7. Outline of the mouth in *B. armatus*.
 Fig. 8. Outline of the mouth in a hybrid of *B. armatus* and *B. improvidus*.
 Fig. 9. Outline of the mouth in *B. improvidus*, var. *assimilis*.
 Fig. 10. Labrum of *B. armatus*.
 Figs. 11-13. Labrum in three different individuals of *B. improvidus*, var. *assimilis*.
 Fig. 14. Setæ from the carinal side of the tergum in *B. armatus*.
 Fig. 15. Setæ from the scutal side of the same piece.
 Fig. 16. Setæ from the scutum in *B. armatus*.
 Fig. 17. Setæ from the tergum in *B. improvidus*, var. *assimilis*.
 Fig. 18. Setæ from the striae of growth on the tergum of *B. improvidus*, var. *assimilis*.
 Fig. 19. Anterior ramus of the third pair of cirri of *B. armatus*, from within, wherefore only the teeth which project beyond the margin are visible.
 Fig. 20. The same ramus from the hybrid, from without.
 Fig. 21. Ninth joint of the outer ramus of the third pair of feet in a large *B. armatus*, from without.
 Fig. 22. Tenth joint of the outer ramus of the fourth pair of feet in *B. armatus*, from without.
 Fig. 23. Seventh joint of the outer ramus of the third pair of feet in the hybrid, from without.
 Fig. 24. The same joint of a *B. improvidus*, var. *assimilis*, from without.

XLVIII.—*Sixth Account of new Species of Snakes in the Collection of the British Museum.* By ALBERT GÜNTHER, M.A., M.D., Ph.D., F.R.S.

[Plates XVII., XVIII. XIX.]

THE following species of Ophidians have been added to the Collection of the British Museum since the publication of the last paper on the same subject in this Journal (July 1866, xviii. pp. 24–29). The total number of species in that collection amounts now to 863, and that of the typical specimens to 830. In the following lists some of the species are marked with an asterisk (*); of these, as well as of some others, I have added descriptions or shorter notices.

I. *List of Species which were formerly desiderata.*

- **Silybura grandis*, *Bedd.* Anamallay Forest. Capt. Beddome.
- *rubromaculata*, *Bedd.* Anamallay Forest. Capt. Beddome.
- **Platyplectrurus trilineatus*, *Bedd.* Anamallay Forest. Capt. Beddome.
- Elapomorphus acanthias*, *Kröyer.* Sierra Leone. J. C. Salmon,
- Liophis* (*Diadophis*) *Arnyi*, *Kennicott.* City of Mexico. Hr. Doorman.
- Tropidonotus nigrocinctus*, *Blyth.* Pegu. Mr. Theobald.
- Ahætulla punctata*, *Ptrs.* Zanzibar. Dr. Kirk †.
- *— *dorsalis*, *Bocage.* Benguella. Dr. B. du Bocage.
- **Tragops javanicus*, *Steindachner.* Pegu. Mr. Theobald.
- Pareas margaritophorus*, *Jan.* Pegu. Mr. Theobald.
- **Boodon variegatus*, *Bocage.* Benguella. Dr. B. du Bocage and Mr. Monteiro.
- Hoplocephalus fuscus*, *Steindachner.* Van Diemen's Land. G. Kreft, Esq.
- Elaps gastrodela*, *Dum. & Bibr.* Chyavetas. Mr. Bartlett.

II. *List of the new Species procured and described since July 1866.*

- **Xenocalamus bicolor*, *Gthr.* Zambeze. Museum of Cape Town.
- **Geophis latifrons*, *Gthr.* Pebas. Mr. Bates.
- *— *bicolor*, *Gthr.* City of Mexico. Hr. Doorman.
- **Simotes amabilis*, *Gthr.* Arrakan Hills. Mr. Theobald.
- *— *cruentatus*, *Theobald.* Pegu. Mr. Theobald.
- *— *Theobaldi*, *Gthr.* Pegu. Mr. Theobald.
- **Ahlabas bistrigatus*, *Gthr.* Pegu. Mr. Theobald.
- **Cyclophis nebulosus*, *Gthr.* Nagasaki. Mr. Whitely.

† Besides the species mentioned in these lists, the following have been sent by Dr. Kirk from Zanzibar:—*Prosymna maleagris*, *Urochis capensis* (Smith), *Psemmophis sibians* in three varieties, *Boodon lineatus*, *Clotho arietans*, *Dasyplexis scabra*.

- **Dromicus viperinus*, *Gthr.* Pebas. Mr. Hauxwell.
- *—— *laureatus*, *Gthr.* City of Mexico. Hr. Doorman.
- **Herpetodryas occipitalis*, *Gthr.* Pebas. Mr. Hauxwell.
- **Tropidonotus Swinhonis*, *Gthr.* Formosa. Mr. Swinhoe.
- **Hydrops callostictus*, *Gthr.* Upper Amazons. Mr. Bartlett.
- **Mimophis madagascariensis*, *Gthr.* Madagascar. Rev. W. Ellis.
- **Rhagerrihis unguiculata*, *Gthr.* Zanzibar. Dr. Kirk.
- *—— *tritæniata*, *Gthr.* East Africa. Mr. Warwick.
- **Ahæstulla Kirkii*, *Gthr.* Zanzibar. Dr. Kirk.
- Dendrophis calligaster*, *Gthr.* Cape York. Purchased.
- **Leptodira nigrofasciata*, *Gthr.* Nicaragua. Dr. Seemann.
- **Dipsas ochraceus*, *Theobald.* Pegu. Mr. Theobald.
- **Pythonodipsas carinata*, *Gthr.* Zambeze. Museum of Cape Town.
- **Lycophidium acutirostre*, *Gthr.* Zanzibar. Dr. Kirk.
- **Callophis japonicus*, *Gthr.* Nagasaki. Mr. Whitely.
- **Elops Batesii*, *Gthr.* Pebas. Mr. Hauxwell.
- **Atractaspis rostrata*, *Gthr.* Zanzibar. Dr. Kirk.

Plectrurus trilineatus (Bedd.).

This is another very interesting addition made by Capt. Beddome to the family of *Uropeltidae*. It differs from *Plectrurus* proper, and, like *Melanophidium*, approaches the *Calamaridae*. The head is remarkably flattened, obtusely rounded in front; no mental groove; tail comparatively long, with a distinct double series of subcaudals, terminating in a horny shield, the edge of which is horizontal, and not vertical as in *Plectrurus*; the shield is one-, and not two-pointed. I propose the generic name *Platyplectrurus* for it.

Silybura grandis.

Rhinophis grandis, Beddome.

This snake is more closely allied to *Silybura ocellata* than to *Rhinophis pulneyensis*, to which it has been compared by its discoverer. However, these species show that the distinction between *Silybura* and *Rhinophis* is scarcely generic, and that they may be united before long.

XENOCALAMUS (g. n. Calamar.).

Body cylindrical, elongate; tail short; head long, depressed, narrower than the neck. Eye extremely small, with round pupil; rostral large, conically produced, the mouth being quite at the lower side of the head; one pair of frontals; vertical enormous; occipitals small; nostril between two shields; loreal none; scales smooth, without apical groove, in seventeen series; anal and subcaudals paired. Maxillary teeth few in number, smooth; palate without teeth.

Xenocalamus bicolor. Pl. XIX. figs. A.

The principal characters by which this interesting snake may be recognized at once are contained in the generic diagnosis, and may be completed thus:—

The vertical shield is the largest shield of the head, six-sided, with an obtuse angle in front and a pointed one behind; the occipitals are comparatively small, ovate shields, forming only a very short suture behind the vertical. The nostril is situated between two shields, the anterior being very small, the posterior elongate, similar in form and size to the præocular; supraorbital and postocular very small; six upper labials, the anterior very small, the third and fourth entering the orbit, the fifth forming a long suture with the occipital, and larger than any of the other labials, the sixth very small again; one large temporal; five lower labials besides the small anterior median shield; the first pair of lower labials form a suture behind the median labial; the second small; the third very large, as long as the others together; a single pair of narrow lanceolate chin-shields. Ventrals 219.

Upper parts uniform black; lower parts and the two outer series of scales uniform white. I have examined a single specimen, 17 inches long (tail mutilated), found by Mr. J. Chapman on the Zambeze.

The three figures on Pl. XIX. represent the head, of twice the natural size.

Geophis elaps (Gthr.).

Rhabdosoma brevifrenatum, Jan.

We have received this snake recently also from Pebas.

Geophis latifrons. Pl. XIX. figs. B.

Scales in seventeen rows. Ventrals 155; anal entire; subcaudals thirty-six. Upper labials six, the third and fourth entering the orbit; two postoculars; temporals 1+2; one pair of chin-shields in contact with four labials. Vertical very broad, broader than long, with the lateral edges short and convergent; frontals longest in their transverse diameter.

Head and neck black, with a yellow ring across the posterior half of the occipitals and the temporal shields. Body encircled by ten pairs of black rings, each ring being as broad as the red interspace. Each scale of the red interspace with a black tip; tail with two pairs of similar rings.

One specimen has been sent from Pebas by Mr. Hauxwell, a correspondent of Mr. Bates. It is 10 inches long, the head being 4 lines, the tail 18 lines.

Geophis bicolor.

Head rather broad, short, and depressed; body and tail of moderate length. Eye small. Anterior frontals about one-fourth the size of posterior; vertical rather longer than broad, with the anterior angle very open; occipitals as long as postfrontals and vertical together, rounded behind; six upper labials, the third and fourth entering the orbit; the fifth is the largest and forms a long suture with the occipital. The remainder of the temple is covered by scale-like temporals 1 + 2. Two postoculars. Anterior chin-shields twice as long as posterior, in contact with four labials. Scales in seventeen rows, smooth, without apical groove. Ventrals 160-168; anal entire; subcaudals 39-48.

Upper parts uniform black; below white; on the two or three outer series of scales the white colour appears in more or less distinct small spots, whilst the black of the upper parts extends to the angles of the ventral shields. Each subcaudal black in front.

We have received four examples of this species in a collection made in the neighbourhood of the city of Mexico by Hr. Doorman. The largest is $14\frac{1}{2}$ inches long, the tail being 3 inches, and the head 5 lines.

Simotes bicatenatus (Gthr.).

Specimens of this snake have been collected by Mr. Theobald in Pegu.

Simotes venustus (Jerdon).

We have lately received well-preserved examples from Mr. Theobald and Capt. Beddome. I find that this snake, originally referred to *Xenodon* by Mr. Jerdon, has only one or two palatine teeth, and is therefore intermediate between *Simotes* and *Oligodon*.

Simotes amabilis. Pl. XVII. fig. A.

Scales in nineteen rows. One præ-, two postoculars; loreal square; seven upper labials, the third and fourth entering the orbit; temporals 1 + 2; ventrals 178; anal entire; subcaudals seventy-five.

Head with the markings usual in the species of this genus. Back with forty-one narrow yellow cross bars, each edged with black in front and behind, the entire marking being scarcely broader than a scale; tail with similar markings, but more or less broken up into spots. Lower parts white, a rather irregular series of small blackish spots along each side of the belly, not continued on to the tail.

One specimen, 10 inches long, was obtained by Mr. Theobald on the Arrakan Hills.

Simotes cruentatus.

Scales in seventeen rows. One præ- and two postoculars; loreal rather longer than deep; eight upper labials, the fourth and fifth entering the orbit; temporals 1 + 2; ventrals 165-167; anal bifid; subcaudals 33-37.

Head and neck with the markings usual in the species of this genus rather indistinct. Body brownish olive, with four very indistinct darker lines; abdomen white, with square black spots; anal shield white; the three or four first subcaudal shields black, the others red; generally another black spot at some distance from the end of the tail.

We have received several examples, under the name given above, from Mr. Theobald, who discovered this snake in Pegu. The largest of the specimens is 15 inches long; one female example, 13 inches long, has five ova in the oviduct, each ovum being 9 lines long.

Simotes Theobaldi.

Scales in seventeen rows. One præ- and two postoculars; loreal much longer than high; eight upper labials, the fourth and fifth entering the orbit; temporals 1 + 2 + 3; ventrals 177; anal bifid; subcaudals 34.

Head and neck with the markings usual in the species of this genus; upper parts of the body brown, with a light vertical line commencing from the occiput and longitudinally dividing the black nuchal spot; another light line on each side of the back, along the fifth outer series of scales. Back crossed by numerous very narrow reticulated black streaks; the outer two series of scales light olive-coloured; abdomen with square black spots; subcaudals uniform white.

This species is allied to *Simotes cruentatus*, but differs from it in the coloration and form of the loreal shield. We have received one example, 16 inches long, from Mr. Theobald, who discovered it in Pegu.

*Ablabes bistrigatus.**

Closely allied to the species of the group *Enicognathus*. Scales in seventeen rows; loreal square; one præocular, reaching to the upper surface of the head; two postoculars; the occipital extends downwards to the lower postocular; one temporal in front, in contact with the lower postocular only; two posterior temporals; upper labials ten, the fourth, fifth, and sixth entering the orbit; ventrals 192; anal bifid; subcaudals 82.

Body brownish olive; upper side of the head and neck black, with symmetrical yellow markings arranged along the margin of the head; a pair of yellow dots on the occipitals; a series of black dots along the vertebral line; a well-defined deep-black streak runs along each side of the body along the meeting edges of the fourth and fifth outer series of scales; it extends to the extremity of the tail. Lower parts uniform whitish.

A single specimen, $10\frac{1}{2}$ inches long, was obtained by Mr. Theobald in Pegu; tail 3 inches long.

Cyclophis nebulosus. Pl. XIX. figs. C.

Body slightly compressed; tail rather short; head of moderate length, distinct from neck. Eye of moderate size; loreal elongate; one præocular, scarcely reaching to the upper surface of the head; two postoculars; eight upper labials, the fourth and fifth entering the orbit, the sixth small, much smaller than the fifth; temporals elongate, 1+2; anterior chin-shields longer than posterior, in contact with four labials.

Scales in fifteen rows, short, rounded, without apical groove; ventrals 174; anal bifid; subcaudals 77.

Greenish olive. Anterior part of trunk with four or six series of obscure nebulous spots, which are confluent into longitudinal bands on the posterior part of the trunk. Head immaculate; lower side uniform whitish.

A single example was obtained by Mr. Whitely at Nagasaki. Total length $9\frac{1}{2}$ inches, length of head 5 lines, of tail 2 inches.

Enicognathus annulatus (D. & B.).

Varies in the number of the black cross bands, which are irregular in shape; ventral shields 140-156. An example from Vera Paz is considerably more slender than others from the city of Mexico. It appears to be rare.

Dromicus viperinus.

Scales in seventeen rows. Ventral shields 160-161; anal bifid; subcaudals sixty. Upper labials eight, the third, fourth, and fifth entering the orbit; loreal higher than long; one præ-, two postoculars; temporals 1+2+3. The posterior maxillary tooth is the longest, and separated from the preceding by an interspace. Upper parts blackish grey, this colour extending, without interruption, over the sides to the edge of the ventral shields. Neck with a darker collar, from which a dark zigzag band proceeds along the median line of the back; it becomes indistinct on the posterior part of the trunk, and re-

appears as a straight band on the tail. Upper part of the head uniform brown, separated from the white colour of the lower part by an indistinct black line, which runs from the orbit to the angle of the mouth, and is indistinctly edged with white below. Ventral and subcaudal shields uniform white, having only a blackish spot on the side, as mentioned before.

Two specimens were sent by Mr. John Hauxwell from Pebas; they are 12 inches long, the length of the head being 4 lines, and that of the tail $3\frac{1}{2}$ inches. Another example, collected by Mr. Fraser in Western Ecuador, appears to belong to the same species.

Dromicus laureatus. Pl. XIX. figs. E.

Scales smooth, in seventeen rows, many with a small apical groove. Form of the head as in *Coronella laevis*; body and tail moderately slender. Eye of moderate size; the rostral does not extend to the upper surface of the head; anterior frontals scarcely half as large as posterior; vertical longer than the snout, but shorter than the occipitals, which are rounded behind; loreal square; one præorbital, reaching to the upper surface of the head, but not extending on to the vertical; two postoculars; seven upper labials, the third and fourth entering into the orbit; temporals 1 + 2 + 3, the anterior in contact with both postoculars; two pairs of chin-shields, nearly equal in length; ventrals 163; anal bifid; subcaudals 95.

A lead-coloured band, three scales broad, runs from the nape, along the median line of the back, to the end of the tail; flanks reddish, with a very indistinct greyish streak along the fourth outer series of scales; two yellow lines across the rostral, the lower runs along the upper labials and across the neck, thus entirely encircling the head; the upper runs along the canthus rostralis, and stops or terminates in the temporal region. Lower parts uniform yellowish.

One specimen was in a collection made by Hr. Doorman in the neighbourhood of the city of Mexico. It is 21 inches long; head 6 lines, tail 7 inches.

The dentition of this species is neither distinctly diacranterian nor syncranterian. The maxillary is armed with nine teeth, gradually becoming stronger, longer, and more widely set behind; the last is conspicuously the longest, but scarcely more distant from the penultimate than this is from the antepenultimate, although these three teeth are much more distant than the others are from each other.

Herpetodryas occipitalis.

Similar to *Herpetodryas Rappii*. Habit moderately slender. Eyes large. Shields of the head normal; eight upper labials, the third, fourth, and fifth entering the orbit; loreal nearly as high as long; præocular reaching to the upper surface of the head, but not extending to the vertical; lateral edges of the vertical nearly parallel; occipitals subtruncated behind. Two or three postoculars; temporals 2 + 2. There are four lower labials in contact with the front chin-shields, which are three-fifths as long as the posterior.

Scales smooth, in fifteen rows. Ventrals 175; anal entire; subcaudals 96.

Upper parts brownish black, with narrow greyish transverse lines, separated from one another by five or six transverse series of scales; a broad white band across the occipitals, extending behind the orbit to the posterior labials; hind margin of each labial black; ventrals pearl-coloured, marbled with black on the sides.

A specimen, 14 inches long, has been obtained by Mr. Hauxwell at Pebas. Head 6 lines, tail $3\frac{1}{2}$ inches.

Tropidonotus Swinhonis. Pl. XIX. fig. F.

Head rather narrow and elongate; trunk rather slender. Eye of moderate size. Scales in fifteen rows. Ventrals 150; anal bifid; subcaudals between 50 and 60. Anterior frontals rounded in front, half as large as posterior; occipitals obliquely truncated behind, longer than vertical; loreal as deep as long; one præocular, reaching to the upper surface of the head; three postoculars. Six upper labial shields, the third and fourth entering the orbit, the fifth very long, nearly as long as the three preceding ones together; temporals 1 + 2, the anterior rather elongate, in contact with the two lower postorbitals. Dentition diacranterian.

Upper parts nearly uniform olive-brown, anteriorly with a few indistinct and irregular blackish spots. Neck reddish olive, with a broad black collar: a small blackish spot below the eye, and an oblique blackish band across the temporal region. Lower parts uniform whitish, slightly and finely marbled on the side.

Formosa. A single specimen, 25 inches long, has been obtained by Consul Swinhoe. Head 9 lines long, tail 5 inches.

Tropidonotus punctulatus (Gthr.).

This snake proves to be a native of Pegu, whence specimens were brought by Mr. Theobald.

Gerarda bicolor (Gray).

This snake is not from the West Indies, but from Pegu, where specimens were collected by Mr. Theobald.

Hydrops Martii (Wagl.).

Hygina fasciata, Gray.

Scales constantly in fifteen series.

Hydrops callostictus. Pl. XVII. fig. B.

Scales in seventeen rows. Anterior frontal nearly twice as broad as long; occipitals as long as the vertical and frontals together; two postoculars; eight upper labials, the fourth entering the orbit; the second upper labial in contact with the posterior frontal; loreal none; temporals 1+1. There are four lower labials, in contact with the front chin-shields. Ventrals 168; anal bifid; subcaudals 90. The upperside of the head and of the back reddish olive. Sides and belly of a lighter colour, approaching to white; body and tail encircled by numerous black rings, each about two scales broad and edged in front and behind by pearl-coloured dots; the bands are frequently broken on the median line of the back and belly. Snout black, with a yellow band across the præfrontal; temple black, separated from the first black ring by a yellowish-white cross band.

One specimen, 11 inches long, was found by Mr. Bartlett at Chyavetas (Upper Amazons).

MIMOPHIS (g. n. Psammophid.).

Body and tail moderately slender, scarcely compressed; form of the head as in *Psammophis*, but with the loreal region less distinctly grooved; rostral shield not enlarged; eye of moderate size, with round pupil; nostril small, placed in a single shield, behind which is another small shield; loreal none, replaced by the posterior frontal, which is bent downwards on the sides; scales smooth, with one apical groove, in seventeen rows, those of the vertebral series not enlarged; ventrals not keeled; anal and subcaudals bifid; the third or fourth maxillary tooth enlarged; posterior maxillary tooth grooved; front teeth of the lower jaw larger than the posterior.

This genus bears a similar relation to *Psammophis* as *Tropidococcyx* to *Tragops*, and illustrates in some measure the affinity between the *Dryophidae* and *Psammophidae*.

Mimophis madagascariensis. Pl. XVIII.

In habit very similar to *Psammophis sibilans*. Snout

slightly pointed, tetrahedral, the canthus rostralis being distinct; loreal region scarcely concave; eye of moderate size. Rostral shield not quite so high as broad, reaching to the upper surface of the head; anterior frontals small, triangular, pointed in front, as long as broad; posterior frontals rather longer than anterior, bent downwards on the sides, and forming a broad suture with the second upper labial. Vertical elongate bell-shaped, as long as the occipitals, which are rounded behind. The nasal shield proper is trapezoid and large, pierced by the small nostril in its upper posterior portion. A smaller quadrangular shield, which is higher than long, is intercalated between the nasal and posterior frontal, and may be considered to be a posterior nasal; there is no loreal. One præocular, concave before the eye, and bent upwards on the upper side of the head, without reaching the vertical. Two postoculars; eight upper labials, the fourth and fifth entering the orbit; temporals small, rather irregular, 2+3. The anterior chin-shields are shorter than the posterior, and in contact with four labials. Ventrals 151, 354; subcaudals 62-170.

Brownish yellow; a broad blackish-brown band, which is four scales broad in the middle of the body, runs from the upper side of the head, along the back, to the tip of the tail. Another, narrower and less intensely coloured stripe runs from the nostril, through the eye, along the meeting edges of the third and fourth outer series of scales; a third, of about the same width, but of a brighter colour, along the meeting edges of the two outer series of scales: all these bands have more or less distinct darker edges. Lower side yellowish, with four faint purplish longitudinal bands.

Three specimens of this beautiful snake were presented by the Rev. W. Ellis to the British Museum. The largest is 22 inches long, head $7\frac{1}{4}$ lines, tail 5 inches. They were collected in Madagascar.

Rhagerrhis unguiculata. Pl. XIX. figs. G.

Scales short, rounded, without apical groove, in seventeen series; ventrals 176; anal bifid; subcaudals 100. Body moderately slender; head short, high, with the upper profile convex, terminating in a broad rostral shield, which is bent downwards and provided with a sharp edge like a nail; anterior frontals much broader than long; posterior frontals not twice as large as anterior, broader than long. Vertical six-sided, with the anterior and posterior angles equally obtuse, and as broad behind as in front; occipitals short, shorter than the vertical, rounded behind. Nostril in a single shield, the

posterior edge of which is rather irregular; loreal as high as long; two præoculars, the upper of which contributes to the canthus rostralis, extending to the upper side of the head, but not by some distance reaching the vertical; two postoculars; eight upper labials, the fifth only entering the orbit; temporal shields small, irregular.

The median lower labial shield is extremely narrow; the chin-shields of nearly the same length, the anterior in contact with four or five labials.

Greyish olive; many of the scales, especially on the hinder part of the trunk, with a dark or blackish dot, a blackish streak through the eye; lower parts nearly uniform whitish.

A single specimen has been sent by Dr. Kirk from Zanzibar. It is 15 inches long; length of the head $6\frac{1}{2}$ lines, of the tail 4 inches.

Rhagerrhis tritarniata. Pl. XIX. figs. II.

I have been in some doubt as regards the systematic position of this snake. Although it evidently belongs to the group of Psammophids, it does not perfectly agree with any of the genera. Having the coloration of a true *Psammophis*, it differs from the species of this genus in its dentition, in which character it agrees with *Rhagerrhis*; but the rostral shield is not so much produced—scarcely more than in *Cælopeltis*, from which it differs in the structure of the scales.

Head rather short, scarcely distinct from neck; body and tail moderately slender. Eye of moderate size; rostral shield as high as long, extending to the upper surface of the head, slightly advancing between the anterior frontals; anterior frontals not very much smaller than posterior; vertical narrow, rather longer than the snout, and conspicuously longer than the occipitals, which are obliquely truncated behind; two nasals; loreal square; præorbital single, slightly concave, not quite reaching the vertical; two postoculars; eight upper labial shields, the fourth and fifth entering the orbit; temporals 2+3+4; two pairs of chin-shields, nearly equal in

smooth, much imbricate, in seventeen rows, with a small apical groove. Ventrals 161; anal bifid; subcaudals 61.

Brownish olive, with three dark-brown bands edged with black. The median band occupies the vertebral series and the halves of the adjoining series of scales, a white line running along its middle; this band commences immediately behind the occipitals, and terminates in the anterior part of the tail. The lateral band runs along the third and fourth outer series and the halves of the adjoining series of scales, commencing

on the nasal shield, crossing the eye and temple, and terminating near the end of the tail. Lower parts uniform whitish.

This snake is probably from South-eastern Africa, and was obtained of Mr. Warwick. It is 20 inches long, the tail being 4 inches, and the head 6 lines.

Ahaetulla dorsalis.

Leptophis dorsalis, Bocage.

Maxillary dentition "coryphodont," the posterior teeth being but little longer than the preceding. Ventral shields keeled. Upper labials nine, three entering the orbit. Anal bifid; ventral plates 184. Temporal shields 1+1+1. Skin between the scales black; each scale with a whitish spot on its outer margin.

Angola.

Ahaetulla Kirkii.

Ventral shields with strong lateral keels. Upper labials nine, two of which enter the orbit; arrangement of temporal shields rather irregular; anal bifid; ventral shields 171, 173; subcaudals 136-140.

Scales smooth, in fifteen rows, without apical groove. Lo-real elongate; præocular in contact with the vertical. Teeth longest behind, in a continuous series.

Green; skin between the scales black; without white spot.

Three examples have been sent by Dr. Kirk from Zanzibar. The longest is 40 inches long; tail 15 inches.

Dryophis argentea (Daud.).

We have lately received specimens of this snake in collections made at Pebas and Yuimaguas, together with *Rhinobothryum lentiginosum*.

Tragops fronticinctus (Gthr.).

Specimens of this snake have been collected by Mr. Theobald in Pegu.

Tragops javanicus (Steindachner).

This is a very distinct species, occurring also in Pegu, where specimens have been collected by Mr. Theobald. The anal shield is sometimes entire, sometimes divided; ventrals 189-192-193. Scales in the coccygeal region generally keeled. Prof. Peters (Monatsber. Ak. Wiss. Berl. 1868) has observed such keeled scales also in *Tragops prasinus*; only a few of our numerous examples of that species show slight traces of keels in that region. *Tropidococcyx* (Gthr.) is based on the difference of the shields of the head (the form of which

approaches that of *Psammophis*, see Rept. Brit. Ind. p. 301), and is more distinct from *Tragops* than *Passerita* from the latter genus.

Leptodira annulata (L.).

A singular, nearly uniform slate-coloured variety, with the markings very indistinct, occurs at Chiavetas, Upper Amazons. It has the scales in nineteen rows.

Leptodira nigrofasciata.

Scales in nineteen rows, smooth, with two apical grooves. Rostrals scarcely reaching to the upper surface of the head; anterior frontals nearly square, two-thirds the size of posterior; vertical as long as the snout and a little shorter than the occipitals, which are rather narrow and rounded behind; loreal as high as long; one præ- and one postocular, the former not quite reaching to the vertical; eight upper labial shields, the third, fourth, and fifth entering the orbit; temporals 1 + 2 + 3; ventrals 174; anal bifid; subcaudals 74.

Body with sixteen broad black cross bands, which are from three to four times broader than the interspaces of the whitish ground-colour, and confluent on the posterior part of the trunk. Head black above, separated by a white collar from the first black band; tail with about eight black cross bands. Lower parts whitish. The posterior maxillary tooth grooved.

One specimen was found by Dr. Seemann in Nicaragua; it is 14 inches long, the tail being $3\frac{1}{4}$ inches.

Dipsas ochraceus.

Scales in nineteen rows, with an apical groove, those of the vertebral series larger than the others. Ventrals 239-242; anal entire; subcaudals 100; nostril rounded, immediately below the anterior frontal; loreal nearly as high as long. One præocular, not reaching to the upper surface of the head; two postoculars; temporals varying in number, the two anterior are elongate and generally in contact with the postoculars; eight upper labials, the third, fourth, and fifth entering the orbit; two pairs of chin-shields, the anterior not much larger than the posterior. Anterior palatine and mandibular teeth not much enlarged.

Uniform brownish olive. Inside of mouth not coloured.

We have received this new snake from Mr. Theobald, who named it. Two specimens, the larger of which is 44 inches long, were found by him in Pegu.

PYTHONODIPSAS.

Head depressed, very distinct from neck; body depressed, Ann. & Mag. N. Hist. Ser. 4. Vol. i.

of moderate length. Eye of moderate size; two pairs of frontals; one vertical; superciliary well developed; occipitals replaced by scales; labials separated from the eye by a ring of scales; scales keeled, in twenty-one rows; subcaudals simple; maxillary with the hindmost tooth slightly enlarged and grooved in its basal portion; anterior maxillary teeth and anterior palatine teeth rather larger than the middle ones.

Pythonodipsas carinata. Pl. XIX. figs. K.

Rostral shield broader than deep, just reaching the upper surface of the head; anterior frontals small, scarcely half as large as posterior; (nostril very narrow, between two small shields*). Loreal region covered by two or three scales, one of which points upwards and reaches the vertical; præorbital larger than the seven other scales which complete the orbital ring; occiput and temple covered by equally small scales, the occipital being represented by a small shield situated behind the superciliary shield; nine or ten small upper labials. Scales much imbricate, with the keel rather flat. Ventrals 192; anal entire; subcaudals 51.

Upper parts yellowish olive, with two dorsal series of blackish spots, the spots of several pairs confluent into cross bands; flanks with smaller and less distinct spots; lower parts uniform white.

I have examined one specimen of this singular snake. It was found by Mr. John Chapman on the Zambezi. The specimen is $24\frac{1}{2}$ inches long, the head being 10 lines, and the tail $3\frac{1}{2}$ inches long.

Lycodon rufozonatus (Cant.).

In two young examples from Formosa the loreal does not quite extend to the eye, although it is produced backwards.

Ophites albofuscus (D. & B.).

Occurs also in Formosa; feeds on lizards.

Boodon lineatus (D. & B.).

Specimens from the Zambezi and Zanzibar have the scales in twenty-five or twenty-seven rows. Its food consists of nocturnal lizards, as well as mammals.

Lycophidium irroratum (Leach).

Colester irroratus, Leach.

Hypsirhina maura, Gray.

Metoprhina irrorata, Gthr.

Alopecion fasciatum, Gthr.

* This portion of the head is unfortunately so much dried that the nostrils have become rather indistinct; they must be extremely small.

We have received from Mr. Salmon several very fine examples of this snake, collected about one hundred miles inland of Sierra Leone, the largest being 16 inches long. I find, from their examination, that this species cannot be separated from *Lycophidium*, the names mentioned having been given to young examples in an indifferent state of preservation. There are two nasal shields, the nostril being in the anterior; the posterior nasal very small. Ventral shields from 164 to 190. The black spots or bands vary in number and extent; they are larger and more band-like in very young examples.

Alopecion annuliferum being most probably a *Boodon*, the genus *Alopecion* may be erased from the system. Bocage's *Alopecion variegatum* is likewise a *Boodon*.

Lycophidium acutirostre. Pl. XIX. figs. D.

Snout much depressed, spatulate, with rather sharp edges. Body of moderate length; tail short. Eye very small; rostral shield very low, extending to the upper surface of the head; anterior frontals about one-fifth the size of posterior; vertical subtriangular; loreal elongate, large; præorbital in contact with the vertical; eight upper labials, the third, fourth, and fifth of which enter the orbit; two postoculars; temporals 1+2+3, the anterior in contact with the lower postorbital only; chin-shields small, the anterior not larger than the first lower labials. Scales in seventeen rows. Ventrals 140, 146 (twice), 145. Anal entire; subcaudals 23.

Upper and lower parts deep black; scales on the sides and the outer part of the ventral shields finely marbled with bluish. Side of the head yellowish, marbled with black; margin of the snout nearly uniform yellowish.

Several specimens, from 8 to 11 inches long, were sent by Dr. Kirk from Zanzibar; two or three were adult females, each with four ova in the oviduct. This snake feeds on small Scincoids. It is a species very distinct from any of the varieties of *Lycophidium Horstockii*, being distinguished by the peculiar form of the snout and the constantly much smaller number of ventral shields.

The figures represent the head, of twice the natural size.

Lycophidium Horstockii (Schleg.).

The museum of Cape Town is in possession of a specimen from Bayana Bay, Madagascar: it represents one of the numerous varieties of this species, and is uniform dark brown above, whitish below, with numerous brown spots. Ventrals 182.

The number of ventral shields varies much in examples which I refer to *L. Horstockii*. I find

208 in one example from West Africa.

208 in one, habit. —?

202–200 in two, variety with square white dorsal spots.

188 in one from the Cape.

176 in one from Angola.

153 in one from Ambrizette.

CYLINDROPHIS.

The snakes of this genus are viviparous.

Hydrophis lapemoides (Gray).

An example, 3 feet long, from Madras, has only one postocular.

Callophis japonicus. Pl. XVII. fig. C.

Ground-colour whitish in spirits, with a reddish tinge. Anterior half and sides of the head black; a black band, one scale broad, runs from the occipital, along the vertical line, nearly to the tip of the tail; another, narrower and less distinct line runs along the meeting edges of the third and fourth outer series of scales. Body with black cross bands besides, the width of which is about one-third of the interspace between them: some extend round the belly, others do not; there are thirteen of them on the trunk and two on the tail. Belly with a series of large round black blotches, each blotch corresponding to the middle of the interspace between two black dorsal bands.

Seven upper labials; two postoculars; ventrals 205; anal entire; subcaudals 31.

One specimen, $9\frac{1}{4}$ inches long, was obtained by Mr. Whitely at Nagasaki.

Elaps Batesii. Pl. XVII. fig. D.

Upper labials seven, none of them in contact with the occipital; one præ-, two postoculars; temporals 1+1+2; ventrals 196; anal bifid; subcaudals 50. Upper parts uniform shining black; trunk with about sixty transverse series of very small yellow specks; each supraorbital provided with a similar spot; lower parts of the trunk white (in spirits), with a few irregular yellow cross bands; lower part of the tail with alternate yellow and blackish bands.

One example, 12 inches long, was sent by Mr. Hauxwell, a correspondent of Mr. Bates, from Pebas.

Elaps filiformis (Gthr.).

An adult example from Bogota differs from the typical specimen in having two postoculars. Ventral shields 295.

Atractaspis rostrata. Pl. XIX. figs. I.

Head broad, depressed; snout slightly turned upwards, the rostral shield being provided with a sharp anterior edge, and extending backwards for some distance between the anterior frontals; two pairs of frontals. Vertical extremely broad; one præ- and one postocular; five upper labial shields, the third and fourth entering the orbit; temporals 1 + 1, the anterior descending between the fourth and fifth labials: a very long lower labial shield corresponds to the third, fourth, and fifth upper labials. Scales in twenty-three rows. Body elongate. Ventrals 227-244; subcaudals simple, 22 or 23.

Two specimens, 22 inches long, were sent by Dr. Kirk from Zanzibar. This is the fifth species of this genus in the Collection of the British Museum.

XLIX.—*On the Terrestrial Mollusca of Dominica and Grenada; with an Account of some new Species from Trinidad.*
By R. J. LECHMERE GUPPY, F.L.S., F.G.S., &c.

Part I. DOMINICA.

DOMINICA is, I believe, the only island in the Antilles of which no list of terrestrial Mollusca has yet been published. In Mr. Bland's Catalogue, in the 'Annals of the New York Lyceum,' still the most complete list we possess of the land-shells of the West Indies, it is stated that no species from Dominica were known to the author. To remedy this defect, I took advantage of a vacation to visit and explore that island, which I found to consist chiefly of mountains composed of volcanic rocks, and ranging from 2000 to 5000 feet high. This is perhaps the highest land in the chain of the West-Indian Islands between Jamaica and South America.

There is but little which may be properly called lowlands in Dominica; but on the lower slopes near the sea I found a few Mollusca, chiefly *Bulinulus exilis*, *Stenogyra octona*, *Succinea approximans*, and *Helicina humilis*. Ascending higher, we find *Helix dentiens*, *H. badia*, *H. Josephina*, *H. nigrescens*, *Amphibulima patula*, *Bulinulus laticinctus*, and *Helicina epistilia*. Excepting the last one, these species are found everywhere above 300 or 400 feet of elevation. The dense and excessively humid forests which cover all the higher

parts of the island afford a congenial habitat to the land-snails. An ascent of Mount Kuliabon, 3000 feet high, furnished me with examples of the four *Helices* already mentioned, *Hyalina Baudoni*, *Amphibulima pardalina*, *Cyclotus amethystinus*, and *Glandina perlucens*. On Morne Diablotin, at the north end of the island, I found *Hyalina Baudoni*, the four *Helices* *Helicina rhodostoma*, *H. conuloides*, *H. plicatula*, *H. velutina*, *Amphibulima pardalina*, *Cyclotus amethystinus*, and *Glandina perlucens*. On the very summit of this mountain, stated to be 5314 feet high, I collected *Helix badia*, *H. Josephineæ*, and *Helicina conuloides*. *Amphibulima pardalina* is another species fond of the thickly wooded heights; but several of the Mollusca (e.g. *Helicina rhodostoma* and *Cyclotus amethystinus*) appeared to cease at about 3300 feet.

The general aspect of the molluscan fauna of Dominica is precisely what we might have expected from its position between the islands of Guadelupe and Martinique, the land-shells of which are well known. Of the total of twenty species determined by me, eleven are found in the neighbouring islands, whilst I have considered nine to be undescribed.

1. *Glandina perlucens*, n. sp.

Testa subulato-turrita, lævis, diaphana, fusco-flavida, vix striatula, lineis distantibus ornata; apex obtusissimus; anfractus 7, parum convexi, lente accrescentes, ultimus appianatus, spiræ longitudinem circiter æquans; sutura valde impressa; columella valde torta, truncata; peristoma simplex, margine externo aliquanto prominente.

Long. 16 millim., lat. maj. 4 millim.; apert. alt. 4, lat. 2.

A subulate-turrite, smooth, brilliantly polished, yellowish-red shell, marked by obscure striæ and by distant variciform lines, of which there are from three to six on a whorl; with a very obtuse apex and seven slowly increasing, scarcely convex whorls, the last somewhat flattened and equal to about half the length of the shell; columella strongly curved, truncate; aperture oval, elongate; peristome simple, its external margin somewhat prominent.

A species allied to *G. arcuata*, Pf., of Jamaica. Of three examples I obtained, one only was of full growth.

2. *Stenogyra octona*, Chemn.

3. *Hyalina Baudoni*, Petit.

I was rather in doubt whether to refer the Dominican shell to this species or to *H. concolor*, Fér. It appears to be rather intermediate between those two very closely allied forms. Its whorls are more like those of *H. concolor* in contour, except in

the convexity of the spire, and in that particular our shell is nearer to *H. Baudoni*; and the balance of characters is in favour of the latter name. The animal is viviparous, often containing twenty young of different sizes. The smallest shells resemble a *Bulla* in shape. The lingual teeth are like those of *H. cellaria*, and the animal is not furnished with any caudal appendage.

4. *Helix Josephinæ*, Fér.

5. *Helix dentiens*, Fér.

6. *Helix badia*, Fér.

7. *Helix nigrescens*, Wood.

These four *Helices* are common throughout the island. Their mandibles and lingual dentition are similar.

8. *Bulimulus laticinctus*, n. sp.

Testa perforata, conico-elongata, tenuis, fusca vel flava, nitida, decussata, castaneo 4-fasciata (in forma β unicolor), fascia media latior; anfr. 6, convexiusculi, regulariter accrescentes, ultimus $\frac{2}{3}$ longitudinis testæ circiter æquans; spira elongata; apex acuminiatus; apertura semiovalis; peristoma simplex, acutum, vix expansum; columella torta, dilatata, reflexa.

Alt. 24 millim., lat. 10; aperturæ alt. 10, lat. 5; anfr. ult. alt. 15.

α . Shell perforate, conic-elongate, fuscous or yellow, thin, shining, decussate, zoned by four dark chestnut bands, of which two are visible on the upper whorls, the second (reckoning from the suture) being the widest; whorls 6, a little convex; peristome thin, columellar margin reflected over the narrow perforation; columella slightly twisted.

β . Like α , but yellowish or greenish, devoid of colour-bands, and somewhat broader.

A species allied to *B. multifasciatus*, but narrow and relatively more elongate, and with only four wide colour-bands.

9. *Bulimulus exilis*, Gmelin.

10. *Bulimulus stenogyroides*, n. sp.

Testa rimata, turrita, elongata, cylindrica, parum nitens, albidocornea sub epidermide brunnea, sinuato-striata; anfr. (? circa 5-6) convexiusculi, ultimus spiræ longitudinem superans; apertura elongato-ovalis, angusta, producta; peristoma simplex, acutum, marginibus callo tenui junctis; columella reflexa.

Long. — ?, lat. $5\frac{1}{2}$ millim.; apert. alt. 6, lat. $2\frac{1}{2}$; anfr. ult. alt. 10.

A rimate, turrite, elongate cylindric, scarcely shining shell, whitish horn-coloured under a brown epidermis, the striæ of

growth somewhat sinuate; whorls (? about five or six) little convex, the last narrow and forming half or more of the length of the shell; aperture narrow, rather produced anteriorly, elongate oval; peristome simple, a little effuse anteriorly, its margins joined by a thin callus on the body-whorl; columella reflexed over the narrow umbilical fissure.

I obtained a single living example of this species; but, unfortunately, the spire got broken off, so that my description is somewhat imperfect. Nevertheless it seems to be a very distinct species; and, although very like a *Stenogyra* in shape, I am inclined to place it rather with *Bulimulus*. It is, perhaps, allied to *B. montivagus*, D'Orb.; but its proportions are much more elongate relatively.

11. *Amphibulima patula*, Brug.

More common on the outskirts than in the interior of the forests.

12. *Amphibulima pardalina*, n. sp.

Testa elongato-ovalis, succinoidea, tenuis, flexibilis, diaphana, leviter decussata, fulvo notata; anfr. 3; spira parva, obtusa; apertura ampla, ante dilatata; peristoma simplex, superne inflexum; sutura descendens.

Long. 20 millim., lat. 11 millim.: spiræ alt. 3; aperturæ lat. 9.

An oval-elongate, *Succinea*-shaped, thin, flexible, somewhat diaphanous shell, finely decussate and generally marked by irregular rows of small, elongate, fulvous spots; having a small obtuse spire and a very large aperture, much dilated anteriorly. The animal resembles that of *Omalonyx unguis*, Fér. (D'Orb. Voy. Amér. Mérid. pl. 22. f. 1-7). The foot is translucent, like a bit of ice dipped in milk, the internal organs showing as a dark variegated patch about the shell, into which the body is incapable of retraction. It lives buried in the very thick moss on the trees in the higher regions of the forest, where the vegetation is always dripping with moisture. *A. pardalina* is very near to *A. tigrina* (Lesueur); but the differences induce me provisionally to assign a new name to the Dominican shell.

Forming my judgment from the soft parts and the lingual dentition, I should separate *Amphibulima* as a genus from *Succinea*. The genus *Amphibulima* might then be divided into the following groups:—

Amphibulima s. strict. Type *A. patula*.

Omalonyx, D'Orb. Type *A. unguis*.

Brachyspira, Pf. Types *A. pardalina* and *A. tigrina*.

13. *Succinea approximans*, Shuttl.14. *Cyclotus amethystinus*, n. sp.

Testa turbinato-depressa, rubra vel straminea, subdiaphana, spirally striata, lineæ incrementi rugosæ; spira depressa, conoidea; anfr. 5, convexi, infra læves, supra (in forma α) spiraliter lirati lineis angustioribus quam interstitia eorum (in forma β læves); umbilicus latus, profundus; apertura parum obliqua; peristoma simplex, continuum, breviter affixum, margine externo parum prominente.

Alt. $8\frac{1}{2}$ millim., lat. maj. 19, lat. min. 15.

Operculum corneum, diaphanum, externo concavum, interne cartilagineum.

α . Shell turbate-depressed, reddish or straw-coloured, subdiaphanous, spirally striate, the striae of growth generally rather rugose; spire depressed, conoidal; whorls 5, convex, smooth beneath, lined above by spiral striae narrower than their interstices, the last scarcely descending anteriorly. Operculum horny, diaphanous, concave externally, cartilaginous within, the nucleus projecting internally; with from ten to fourteen very narrow whorls, their rather lamellar outer edges slightly free.

β . Smooth, shining, not striate spirally, generally somewhat more depressed, deep chestnut or reddish brown; whorls a little flattened near the suture. Operculum as in α .

This is a notable species, owing to its operculum, which departs widely from that usual in this genus. In no specimen did it present the least approach to the shelly consistency of the opercula of most *Cycloti*. The spiral striation of the shell is generally very distinct, but in var. β it is altogether wanting. The present species approaches *C. popayanus* in shape, being, however, a little more depressed; and it is not closely allied.

15. *Helicina plicatula*, Pfeiffer.

Some examples of this species are reddish, and some are yellow.

16. *Helicina epistilia*, n. sp.

Testa orbiculato-conoidalis, solidiuscula, lineis incrementi striata, rubro-brunnea vel obscure flava; spira elevata, apex acuminatus; anfr. 5, paulum convexi, inferne applanati; sutura paululum crenulata, parum descendens; apertura parva, semiovalis, lata æque ac alta; peristoma anguste reflexum, parum incrassatum; callus basalis tenuis, vix distinctus; columella simplex.

Alt. $5\frac{1}{2}$ millim., lat. $8\frac{1}{2}$.

Operculum pallide corneum.

An orbiculate-conoidal, obscurely yellowish or reddish shell,

striate by lines of growth; spire raised, with a pointed apex; whorls 5, moderately convex, flattened beneath; suture somewhat crenulate, slightly descending; aperture rather small, as broad as high; peristome narrowly reflexed. Operculum pale horn-coloured.

A species akin to *H. Dysoni*, but without colour-bands. It has a more convex form and a flatter base than *H. barbata* (Guppy), and in the former of these particulars it is more like some examples of *H. foveata*, Pf.

17. *Helicina humilis*, n. sp.

Testa orbiculato-depressa, lineis incrementi regulariter et dense striata, pallido-fusca; spira brevis, depressa; apex vix acuminatus; anfr. circa 4, carinati, superne applanati, ultimus paulo productus; apertura obliqua, semiovata; columella brevis, in nodum terminans; callus basalis amplus, tenuis, leviter circumscriptus.

Alt. 4 millim., lat. 7.

Operculum corneum, ad marginem rubescens.

A depressed pale-fusca *Helicina*, striate obliquely by very close and regular lines of growth; whorls about 4, flattened above and carinate on the periphery; aperture oblique, semi-ovate; peristome somewhat thickened and dilated.

Allied to *H. velutina* and *H. subfusca*, but generally smaller and more obscurely coloured. Most examples, though living, have a weathered appearance, which exhibits the close striation very plainly. It may possibly prove to be a marked variety of *H. velutina*.

18. *Helicina velutina*, n. sp.

Testa orbiculato-depressa, oblique valde striata, rubro-brunnea, epidermide velutina induta; epidermis decussata, pubescentia in ordinibus punctorum exiguum disposita; spira brevis, apex breviter acuminatus; anfr. 5, vix convexi, ad peripheriam carinati, carina distincte lirata lineis pubescentibus; apertura obliqua, semiovata; peristoma parum incrassatum et expansum; columella in nodum distincte terminans; callus basalis amplus, circumscriptus.

Alt. 5 millim., lat. 8½.

Operculum tenue, corneum, margine rubescens.

Shell depressed, somewhat strongly striate obliquely, dark brownish red, covered with a velvety epidermis, which is decussate, the pubescence disposed in rows of minute dark points; spire short, apex somewhat pointed; whorls five, keeled on the periphery, the keel bearing two or three distinctly marked spiral lines of pubescence; base little convex, very decidedly decussate.

A species somewhat like *H. subfusca*, but distinguished by

being more keeled, by its pubescence, and by its basal callus and columellar knot.

19. *Helicina rhodostoma*, Gray.

A handsome species, variable as to colour, often nearly white. The expanded peristome varies from white, through orange and red, to a deep chestnut. The operculum of all my specimens is large, thin, and horn-coloured. The spine at the base of the columella is also of variable length, and sometimes it is obsolete.

20. *Helicina conuloides*, n. sp.

Testa conica, trochiformis, tenuis, lævis, nitens, diaphana, rubro-brunnea; spira conica, elevata; apex acuminatus; anfr. 6, vix convexi; apertura leviter obliqua; peristoma tenue, rectum; columella in callum albidum et circumscriptum dilatata.

Alt. 4 millim., lat. $5\frac{1}{2}$.

Operculum tenue, diaphanum, margine interno paulo incrassato.

A conic-trochiform, thin, smooth, shining, diaphanous, reddish-brown *Helicina*, with an elevated conic spire and a pointed apex; whorls 6, scarcely convex; aperture slightly oblique; peristome thin, straight; columella dilated into a whitish, rather circumscribed, not very large callus. Operculum thin, diaphanous, somewhat thickened on the inner margin.

Allied to *H. trochulina*, D'Orb. (Moll. de Cuba, tab. 20. f. 10-12). It differs in being scarcely so high relatively, in its more pyramidal form, and its thinner peristome, which is not expanded; its colour, also, is reddish brown, instead of yellow. One of my examples was furnished with two opercula. I have named the species from its great resemblance, in colour, shape, and texture, to the shells of the subgenus *Conulus* of *Zonites*.

Part II. GRENADA.

1. *Veronicella lævis*, Fér.

Vaginulus Sloanei, Fér. (Guppy).

2. *Conulus vacans*, Guppy.

It has been suggested to me that this mollusk, which I described as occurring in Trinidad, is possibly the same as *Stenopus lividus* of Guilding. I had, however, made a careful comparison of Guilding's figure, and it seemed to me that the two were distinct, although there can be little doubt that both mollusks belong to the same group. I venture to think, how-

ever, that, in view of their affinities, the name *Conulus* is the proper one for the group. The name *Stenopus* cannot be allowed to stand, having been preoccupied for a crustacean. Such shells as *Conulus semen-lini* and *C. Gundlachi* are evidently not separable from the present group. The mucus-pore and retractile appendage on the truncate tail are found in the genus *Nanina* and also in *Zonites* (as restricted in 'Die Heliceen' of Albers); and *Conulus vacans* has also the median part of the foot defined as in *Nanina* (e. g. *Helicarion Freycineti*). I think, therefore, that the best classification will be to refer to *Zonites* all those species (of the group now under consideration) in which a caudal appendage exists. *Conulus* will thus form a section of *Zonites* comprising the minutely perforated trochiform species. To the group *Ægopsis* will be assigned those species having shells like *Stenopus cruentatus*, Guild., *S. Guildingi*, Bland, and *Helix nitensoides*, D'Orb. The genus *Hyalina* will then consist of the species, such as *H. cellaria* and *H. nitens*, which have no caudal appendage.

3. *Helix diminuta*, C. B. Adams.

4. *Helix perplexa*, Fér.

I did not collect this species myself; but I have received examples of it from a former Governor of Grenada, His Excellency Mr. Keate.

5. *Plekocheilus glaber*, Gmelin.

var. *grenadensis*.

This differs from the Trinidad shell described by me as *P. auris-sciuri* in its greater solidity and more ventricose figure, and in being less impressed in the middle of the last whorl. Its lip is thicker, and its columellar tooth more prominent. In all these respects, except the compression of the last whorl, it agrees better with the Brazilian *P. glaber* than the Trinidad form does.

6. *Bulimulus indistinctus*, n. sp.

Testa subperforata, tenuis, oblongo-conica, ventricosa, pallido-brunnea vel lutescens; anfr. 6, regulariter accrescentes, ultimus ventricosus, $\frac{3}{4}$ testæ longitudinis æquans; spira conica, apex acuminatus; apertura oblongo-ovalis; peristoma simplex, acutum, haud expansum; margine columellari reflexo.

Long. 23 millim., lat. 12; aperturæ long. 11, lat. 6.

Shell subperforate, somewhat thin, oblong-conic, rather ventricose, pale reddish brown or inclining to yellowish white; whorls 6, gradually increasing, the last somewhat ventricose, equal to about two-thirds of the length of the shell; spire

conic, sharp; aperture oblong oval; peristome acute, not expanded; columellar margin reflexed over the narrow umbilicus. The dimensions given above are those of a typical example.

This shell is probably nearest to *B. tenuissimus* and *B. sepulchralis*. It is larger than either of those species, and approaches to *B. liliaceus* in some respects.

7. *Tornatellina lamellata*, Pot. & Mich.

The Grenada shell to which the name *T. Funcki* is applied in Bland's list (1861) is identical with the form from Trinidad which has recently been described by Dr. Pfeiffer as *T. Blandiana*, and which I refer to the *T. lamellata* of Potiez and Michaud.

8. *Stenogyra caracasensis*, Reeve.

9. *Stenogyra octona*, Chemn.

10. *Stenogyra plicatella*, Guppy.

The description of this species will be found under Part III., Trinidad. The Grenada specimens are intermediate between the vars. *a* and *γ*. They were probably included in Bland's list as *St. subula*, Pfeiff.

11. *Ennea bicolor*, Hutton.

12. *Succinea approximans*, Shuttl.

13. *Cyclotus grenadensis*, Shuttl.

This is very nearly allied to *C. rugatus*, Guppy. It may be distinguished by the comparative smoothness of the last whorl, upon which, in *C. grenadensis*, the wrinkled striæ become obsolete. The present species is of a lighter colour than *C. rugatus*.

14. *Helicina Heatei*, Pf.

I did not collect this species.

Part III. TRINIDAD.

With one exception, the species now described have not hitherto been recorded from Trinidad; and most of them are minute and of rare occurrence. *Stenogyra plicatella* was included in my list in the 'Annals' (ser. 3. vol. xvii. p. 50) as *Bulimus octonoides*, Adams, from which, however, I find it is very different. *Zonites Guildingii*, *Helix bactricola*, and *Helicina ignicoma* inhabit the mountains of Aripo.

The proportion of minute species of shells in Trinidad is

somewhat noticeable. Not less remarkable is the rarity of individuals—so much so that travellers may be pardoned for having doubted if land-shells exist in Trinidad. The only exception is perhaps *Stenogyra octona*. *Bulimus oblongus* and *Cyclotus translucidus*, however, are rather abundant in some very restricted localities. A contrast to this is presented by the Antilles, where an hour's ramble or a search amongst almost any group of balisiers or grove of trees is generally rewarded by examples of the more abundant species.

1. *Spiraxis simplex*, n. sp.

Testa cylindrico-turrita, longitudinaliter sinuato plicata, lutescens, epidermide straminea induta; anfr. 8-9, vix convexi, ultimus longitudinem spiræ superans; sutura incisa; apertura ovato-oblonga; columella valde torta vel reflexiuscula, truncata; peristoma simplex, supra et in mediis partibus paulo prominens.

Shell turrite, rather thin, longitudinally sinuate-plicate, whitish, covered with a light straw-coloured, somewhat shining epidermis; whorls 8-9, scarcely convex; aperture ovate-oblong; peristome simple, prominent above, receding below.

Var. α . Columella strongly twisted, broadly and obliquely truncate; aperture much dilated anteriorly.

Var. β . Larger, rimate; columella reflexed, scarcely truncate.

Dimensions of three examples.

α . Height	14 mill.	greatest diam.	4	height of last whorl	$7\frac{1}{2}$	of apert.	$4\frac{1}{2}$
"	12	"	5	"	$7\frac{1}{2}$	"	5
β . "	15	"	6	"	$7\frac{1}{2}$	"	$4\frac{1}{2}$

2. *Stenogyra plicatella*, n. sp.

Bulimus octonoides, Guppy, non Adams.

Testa subulata, elongato-cylindrica, subperforata, cornea, parum nitens, sinuato-striata; anfr. 8-9, lente accrescentes, convexiusculi, ultimus ventrosus; sutura valida; apertura elongata, ovalis; peristoma simplex, supra paulo sinuatum, marginibus callo tenui junctis; columella recta, super umbilicum late reflexa.

α . Shell subulate, elongate-cylindrical, subperforate, horn-coloured, slightly shining, marked by numerous sinuate striae; whorls 8-9, slowly increasing, the last somewhat ventricose; aperture elongate-oval; columella reflexed over the narrow perforation.

β . Generally larger; whorls flattened, and impressed in the middle by an indistinct sulcus; the last whorl not ventricose; outer margin sinuate above; aperture with its margins joined by a callus.

γ . Smaller, more slender, waxy-white, shining; columella arcuate, not reflexed, sometimes subtruncate.

This species is very variable in dimensions as well as in its other characters, as the following measurements of three varieties will show :—

α.	Length	13 millims.,	breadth	3½,	height of aperture	3.
β.	"	16	"	"	3½	"
γ.	"	9	"	"	2	"
						1½

This is generally a longer and larger shell than *S. octonoides*, to which I had previously referred it. The var. γ also is longer, though more slender, than the Jamaican species. But *S. plicatella* is really more near to *S. subula*, Pfr. In uniting the three forms now described under one name, I am guided by the characteristic striation and by the gradation of forms.

3. *Stenogyra coronata*, n. sp.

Testa obsolete rimata, subulata, cylindrico-fusiformis, albida vel cornea, costellibus distantibus ornata; anfr. 8-9, vix convexi, superiores lente accrescentes et gradati, inferiores subaequantur, ultimum parum arcuatus; sutura impressa: apertura angusta, elongato-ovalis; peristoma simplex, marginibus callo junctis.

Long. 7 millim., lat. 2; apert. alt. 1½, lat. ½.

Shell obsoletely rimate, subulate, fusiformly cylindrical, white, adorned by low, distant, somewhat sinuate, longitudinal riblets, of which there are about eighteen on a whorl; whorls 8-9, scarcely convex, the upper ones step-like, slowly increasing, the lower ones nearly equal, the last somewhat narrowed; aperture narrow; peristome simple, its margins joined by a narrow callus on the body-whorl.

Allied to *S. gracillima*, Pfr., Cuba. The group *Melaniella*, of which this is a member, appears to be related to *Cylindrella*, whilst the forms like *S. plicatella* and *S. octona* seem to approach *Spiraxis*.

4. *Zonites Guildingi*, Bland.

Stenopus Guildingi, Bland, in Ann. Lyc. N. H. New York.

I would refer to what I have said under Part II., Grenada, when treating of *Conulus vacans*, for my reasons for rejecting the name *Stenopus*.

This shell is so like *Hyalina cellaria*, Müll., that, were a dozen examples of each mixed together, it would be difficult to assort them. The animal differs, according to Bland, in having a caudal appendage, and is therefore referable to *Zonites*, and not to *Hyalina*. I have only found this species on the heights of Aripo, 2000 to 2700 feet high, and have had no opportunity of examining the animal. Mr. Bland's examples were from Porto Cabello in Venezuela.

5. *Zonites implicans*, n. sp.

Testa minuta, discoidea, aperte et late umbilicata, albida, pellucida, nitens; anfr. 4, depressi, superne applanati, lente accrescentes; spira applanata; apertura suborbicularis.

Alt. $\frac{1}{2}$ millim., lat. maj. 2; apert. alt. $\frac{1}{2}$.

A minute, discoidal, widely umbilicate, whitish, smooth, shining shell, with four depressed, slowly increasing whorls, flattened above; spire scarcely, if at all, rising above the last whorl; aperture suborbicular.

This is distinguished from *Z. umbratilis* by the absence of striation, by its planorbiform shape, depressed spire, and wider umbilicus, and by its large suborbicular aperture, scarcely encroached upon by the penultimate whorl.

6. *Zonites umbratilis*, n. sp.

Testa minuta, depressa, profunde umbilicata, distincte et regulariter striata, diaphana, cornea vel albida; anfr. $5\frac{1}{2}$ –8, lente accrescentes; spira convexa, depressa; apertura lunaris; peristoma simplex.

Alt. $\frac{3}{4}$ millim., lat. $1\frac{1}{2}$; apert. alt. $\frac{1}{2}$.

A minute, depressed, deeply umbilicate, horn-coloured shell, distinctly and regularly striate; whorls five and a half or six; spire convex, depressed; aperture lunate; peristome simple.

This species has a wider and deeper umbilicus than the last, showing all the whorls. Some examples are a good deal more depressed than others, and approach *Z. implicans* in that respect; but the striation is a definite character. It is possible that these two species may, upon examination of the soft parts, prove not to have caudal appendages, and will then be referable to *Hyalina*, not to *Zonites*.

7. *Helix bactricola*, n. sp.

Testa pyramidalis, conoidea, perspective umbilicata, dense radiatim costellata, corneo-fusca; anfr. 7, angusti, lente accrescentes, ultimus ad peripheriam valde carinatus; spira conica; apex laevis, nitens; apertura angulariter subovalis, leviter obliqua; umbilicus infundibuliformis, $\frac{1}{3}$ latitudinis testae circiter aequans; peristoma simplex, acutum, margine columellari parum dilatato.

Alt. $2\frac{1}{2}$ millim., lat. 4.

A small, pyramidal, deeply umbilicate, fuscous-horny *Helix*, with seven narrow, slowly increasing, closely costellate whorls, the last carinate on the periphery; spire conic; apex smooth, shining; umbilicus infundibuliform, about one-third the width of the shell; peristome simple; acute; columellar margin slightly dilated.

This little shell is ornamented in a manner similar to *H.*

diminuta and *H. perspectiva*; but it is much more conical than those species or any of their allies that I am acquainted with, having in this respect more of the shape of *H. labyrinthica*, Say.

8. *Bulimulus tenuissimus*, Fér.

A species not hitherto distinguished by me from *B. fraterculus*. If the Trinidad form now recorded is really *B. tenuissimus*, it differs from Antillian examples in having a narrower mouth.

9. *Pupa uvulifera*, n. sp.

Testa umbilicata, cylindrica, paulum ovata, leviter striatula, corneobrunnea, parum nitens; anfr. 5-6, convexi; apertura semi-ovata, plicis munita, plica parietalis verticalis, lamelliformis; margo externus incrassatus, reflexus, margo columellaris late reflexus; umbilicus apertus, haud profundus.

Long. 3 millim., lat. 1.

Allied, probably, to *P. jamaicensis*. It is of somewhat stouter figure than that species.

10. *Pupa auriformis*, n. sp.

Testa subperforata, ovata, brunnea, subpellucida, leviter striata, vix nitens; anfr. $4\frac{1}{2}$ -5, convexi, ultimus dimidiam longitudinem superans; spira brevis, convexa, apex obtusus; apertura semi-ovalis, auriformis, plica parietali munita; peristoma incrassatum, reflexum, margine externo valde sinuato, margine columellari late reflexo.

Long. 2 millim., lat. $1\frac{1}{2}$.

Distinguished from the last by its shorter and more ovate figure.

11. *Helicina ignicoma*, n. sp.

Testa orbiculato-conoidalis, radiatim sinuato costellata, tenuis, subdiaphana, nitens, subrufa; spira brevis, conoidalis; apertura oblique semiovata; columella brevissima, simplex; peristoma anguste expansum et reflexum, margine basali parum sinuato; callus basalis tenuis, albidus.

Alt. 3 millim., lat. maj. $4\frac{1}{2}$, lat. min. 4.

Operculum tenue, diaphanum.

An orbiculate conoidal *Helicina*, sculptured with numerous fine, oblique, somewhat sinuate riblets; with five whorls, the last somewhat carinate; aperture oblique, semiovate; peristome narrowly expanded and reflected; basal margin slightly sinuate.

Very closely allied to *H. rugosa*, Pf. (Cuba), and scarcely less so to *H. plicatula* (Martinique, Dominica, &c.). One character gives a ready distinction: in the two species men-

tioned there is a sort of tooth on the basal margin of the peristome, whilst in *H. ignicoma* the basal margin is only slightly sinuate.

Note.—The shell identified by me with *Bulimus immaculatus*, Reeve, seems probably not to be that species, but an uncoloured variety of the Trinidad form of *B. multifasciatus*, determined to be *B. vincentinus*, Pf.

The *Planorbis* regarded as identical with a Cuban species should be *P. terverianus*, not *terversanus*.

Port of Spain, Trinidad, April 1868.

L.—*Carcinological Gleanings.* No. III.

By C. SPENCE BATE, Esq., F.R.S.

[Plate XXI.]

Dr. Cunningham writes me from

At sea, November 8, 1867.

(Between Monte Video and Magellan Strait.)

MY DEAR SIR,

I have long had it in my mind to write to you, as you were so good as to express a wish to hear from me occasionally during my absence from the United Kingdom, when I had the pleasure of meeting you at Plymouth last year; and I now put my intention into execution. We left Plymouth on the 8th of September, 1866, but encountered such a severe gale that after battling with it and vainly attempting to run into Brest, we were forced to return to the Sound on the 10th, and lay there till the evening of the 17th, when we again set forth, and, after a rather rough passage, reached Madeira, where we remained for about a week. Unfortunately, we were placed in quarantine for the first five days of our stay, so that I was not able to see nearly as much of the island as I wished. So much has been said of the wonderful beauty of Madeira that I will not enlarge upon it, but content myself with observing that I think it is about the most lovely place I have seen since I left home. I accomplished a little dredging in the Bay of Funchal, and obtained a variety of Mollusca, chiefly belonging to European types. A *Dentalium* was specially abundant in the fine mud of the bottom, existing in hundreds. I, however, met with no Crustacea. I had a delightful ride up the Grand Canal on the 2nd of October; and on the evening of the same day we left Madeira for St. Vincent, in the Cape Verde group. There we arrived on the forenoon of the 9th, and remained four or five days, in the course of which I had some pleasant rambles. I need hardly say that St. Vincent is noted for its extreme

sterility; but, owing to the prevalence of heavy rains, which had shortly before taken place, it was much greener than usual at the time of our visit; and I was surprised by the variety of plants I met with. I devoted one afternoon to marine researches, and I met with a considerable number of *Mollusca* and a few *Crustacea* (principally crabs). I also got a species of *Hippa* or *Remipes*, which burrows in the sand, and is, I was informed, employed as bait for fish. We took our departure early in the evening of the 13th for Rio. In the course of the voyage I employed the towing-net whenever practicable, and with tolerable success, obtaining specimens of *Ianthinae*, various *Pteropods*, *Porpita*, *Veella*, &c. I saw some beautiful *Physalia*, but did not capture any. On the 16th I got a large suctorial crustacean off the gills of a flyingfish which flew on board; and I was nearly forgetting to mention that on the 14th I got a specimen of *Alima hyalina* [Appendix, I.] in the towing-net. We entered the magnificent harbour of Rio de Janeiro late on the evening of the 2nd of November, and we stayed till the afternoon of the 18th. On the stones in shallow water in the harbour an Isopod allied to our British *Ligia* [App., II.] was abundant. We encountered two gales between Rio and Monte Video, where we arrived on the 23rd. During our stay of nearly a fortnight I saw as much as I could of the neighbourhood. The country is very monotonous, consisting for the most part of gently undulating pampas covered with tall thistles. Some parts of these plains, however, are rendered beautiful by the beds of purple and scarlet *Verbenas*. The marine life except the fish, which are numerous, is barrenness itself. One day when I took a long walk along the beach outside the town, and diligently searched for marine animals in the rock-pools, the only living thing that I could find was a small dusky-coloured shore-crab, which existed in numbers. I forgot to say that between Rio and Monte Video I one day procured three specimens of an *Idotea* [App., III.; Plate XXI. fig. 1], or some closely allied form, in the towing-net, 200 miles off land. They were at first of a brilliant blue tint, but have faded in the spirit in which they were put. We left Monte Video on the 6th December, and, after spending a day at Maldonado, shaped our course for the Strait, which we entered on the 21st. On the afternoon of the 22nd we anchored off the Chilian settlement of Puntas Menas, better known to us as Sandy Point; and shortly after, I landed for the first time in Patagonia. It is a truly delightful sensation to land for the first time in a new and wild country, and I greatly enjoyed my walk that day. Pursuing my way along the beach, the first Crustacean I met with was *Serolis Fabricii*,

with whose curious form I had long been familiar from figures. This animal occurs plentifully about Sandy Point, and was taken in hundreds in our seine. When on the ground, it crawls along very sluggishly; but I have seen it paddling rapidly on its back along the surface of shallow pools. The same day I found numerous fragments of a large spiny *Lithodes*, very closely resembling our *L. arcticus*, about which we had some correspondence a year or two ago. This and another species of the same genus, which is not nearly so spiny, the spines being replaced in great part by tubercles, appear to be two of the most abundant Crustacea in the eastern part of the Strait. In both, as in all the other foreign species of *Lithodes* which I have had an opportunity of examining, the pleon is formed on the same plan as that of our British one; *i. e.* in the male the plates are symmetrical, while in the female they are prominently asymmetrical. I got a small male specimen of what I think may be a third species, at Port Famine, one day we spent there. I procured several other Decapoda in the Strait, a small *Munida* [App., IV.] among the number, and a variety of sessile-eyed Crustacea, though not so many as I anticipated. I got one or two *Nymphons* and a species of *Hyperia* [App., V.]. We left the Strait about the middle of February for the Falkland Islands, to get fresh supplies of provision and coal, and reached Stanley Harbour in the course of three days. While we were there, the weather was very broken, so that I could not accomplish any long excursions; but, as far as I could judge, there appears to be a very great similarity between the fauna and flora of the Falklands and those of the Strait. We left Stanley on the 2nd of March, and on the following day, in the forenoon, we noticed several brilliant scarlet-coloured patches in the water floating past the ship. We investigated their nature by means of a bucket let down over the side, and found they were composed of multitudes of a small macrurous decapod which swam rapidly about by rapid flexions and extensions of the tail, the movement being backwards, as in our common lobster. I preserved several specimens of the animal, besides making a sketch of it [App., VI.; Pl. XXI. fig. 2], which I send to you. The entire length of the crustacean, when the tail, which was ordinarily curved underneath the body, was extended, was about three-fourths of an inch; and the limbs bearing the chelæ were nearly an inch long. The general colour was scarlet, the eyes, a large patch on the carapace, and a line extending along the abdominal segments bluish black. I have not been able to identify the animal from the descriptions I have with me. I ought, however, to state that I have a very small stock of books at hand. Captain Mayne

has pointed out to me that in the narrative of the voyage of the Nassau fleet, undertaken in 1623, as given in Binney's Voyages, vol. iii. p. 9), it is recorded that on the 19th and 20th of January, 1624, when the fleet was off the coast of South America in lat. $42^{\circ} 15' S.$, "the sea near them was in many parts discoloured with an infinite number of small red shrimps." On our return to the Strait, we continued our operations till the middle of June, when the increasing severity of the weather caused us to move northwards for winter-quarters. We reached Rio de Janeiro on the 1st of July, and remained there for three months and a half. I need not descant on the glorious scenery or the wonderful profusion of animal- and plant-life in that magnificent country; for that, I presume, is well known to you. I could not afford time for any very long journeys, but went far enough to see the virgin forests in all their glory. I paid two visits to the house of a most hospitable Scotchman who lives on the Serra do Mar, about fifty miles from Rio; and I spent a few days at Tijuca, about ten miles from the city, where I saw the most wonderful exhibition of boulders that it has ever been my lot to witness.

The mention of Tijuca reminds me of a matter that I shall feel much obliged to you if you can give me a little information upon, viz. how far is the development of the land and freshwater decapods made out? I am aware that the crayfish is stated not to undergo any metamorphosis in the young state; but I have not been able to ascertain, in the limited number of books which I have here for consultation, whether the same thing holds good in the Brachyurous Decapoda. I obtained several specimens of a crab, in the province of Rio de Janeiro, which frequents streams and damp rocks in their vicinity; and while exploring the banks of a cascade in the neighbourhood of Tijuca, I obtained a female specimen, which, to my surprise, had between fifty and sixty fully developed live young ones under the pleon, in the ordinary position of the ova. These little creatures were very active, and several escaped on the parent being captured; but I have preserved a number of them, and I send you specimens in this letter, together with a careful sketch of the parent. This occurrence, it appears to me, goes far to prove that this species either undergoes no marked metamorphosis between the egg and the perfect animal, or else that the metamorphosis takes place while the young animal is beneath the pleon of its parent. The body of the adult crab is of a dull purple colour; the legs are of a considerably paler tint. [App., VII.; Pl. XXI. fig. 3.]

I obtained several species of marine Crustacea while at Rio. In an excursion which I made along the beach outside the harbour, I saw many specimens of an *Ocypoda*, but only succeeded in capturing one, owing to the extreme rapidity of their movements; and on another occasion I obtained specimens of a *Lupea*, a *Hepatus*, and a *Hippa*, in Five-fathom Bay.

In the month of September the screw of the vessel was raised in order to clean it, and I found numbers of *Caprella* [App., VIII.] clustering amongst the tufts of zoophytes with which the metal was profusely covered. I send you specimens of this, as well as of a crustacean * which has occurred in plenty in the towing-net several times in the course of our voyage southwards to the Strait. We expect to enter the Strait in the course of a couple of days, and shall be there and in Smyth's Channel for six or seven months, after which we shall probably spend a few months at Valparaiso. If you have leisure to write me a few lines, it will be doing me a great favour; for I am very much cut off at present, as you may imagine, from scientific intelligence. My address will be "H. M. S. 'Nassau,' Valparaiso, via Panama."

With kind regards, believe me,

My dear Sir,

Very truly yours,

ROBERT O. CUNNINGHAM.

Appendix. By C. SPENCE BATE.

I. *Alima hyalina*.—From researches made by Dr. Power during his stay in the Mauritius, and which are now in my hands preparatory to publication, I have great reason to believe that the genus *Alima* is but the second stage in the development of the genus *Squilla* and its allied forms.

II. *Ligia*.—No species (that I am aware of) has been recorded from the eastern coast of South America. It may therefore be *L. Baudiana* of Milne-Edwards, from the Gulf of Mexico, which bears a very near general resemblance to the British species. The habitat, however, is very remarkable; for the European species is never found in water, but only within reach of the spray of the sea.

III. *Idotea annulata*, Dana (Pl. XXI. fig. 1).—The deep blue colour of which Dr. Cunningham speaks appears to be a peculiarity belonging to pelagic species. I have received specimens of this same from Dr. Wallich, who says that it "is a parasite on *Physalia*, almost invariably adherent to the

* *Idotea annulata*.

float." He took them between the Bay of Bengal and the Cape of Good Hope. The specimen from which Dana described the species was "taken in the Antarctic seas south of New Holland."

IV. *Munida*.—Probably same as VI.

V. *Hyperia*.—Having received several specimens of these from Dr. Cunningham, I have been enabled to identify them as being *Themisto antarctica* of Dana.

VI. (Plate XXI. fig. 2).—Judging by Dr. Cunningham's drawing, I think that these must be the young of *Galathea monodon* of Milne-Edwards, of which the *Munida* (*Galathea*) alluded to in No. IV. as being captured in the Strait was a stray specimen.

VII. *Uca Cunninghami* (Pl. XXI. fig. 3).—The development of the land-crabs, of which this is one, has been carefully worked out and figured, in the 'Transactions of the Royal Society,' by Prof. Westwood. I know this species only by Dr. Cunningham's figure, and place it in the genus *Uca* rather than in that of *Gecarcinus*, because there are no teeth or spines on the legs. The two genera, as well as those of *Cardisoma* and *Gecarcoidea*, are distinguished from each other by the different form of the gnathopoda, which, not being shown in Dr. Cunningham's drawing, I cannot appeal to. But since the species of the several genera described by M. Milne-Edwards are distinguished by having rows of spines or teeth on the walking-legs, I think it more probable that this species may be more closely allied, through the form of the oral apparatus, with *Uca* than with either of the others.

Female. Carapace circularly oval; lateral margins not converging until over the penultimate pereopod, then suddenly narrowing to about one-third of the broadest diameter of the carapace; anterior or intraorbital margin smooth and continuously emarginate; latero-frontal margins rounded, not defined, furnished with two short teeth formed rather by depressions than dental elevations. Orbits broad, and not deeply impressed in the carapace. Antennæ short. First pair of pereopoda chelate, unequal, right the larger; chelæ strong, having the internal margin of digital process of the propodos straight, tapering, and armed with four or five strong tubercles; dactylos curved, tapering, and armed with one or two small tubercles. The rest of the pereopoda are subequal in length, the last being somewhat the shortest, and have the tarsi smooth and unarmed. The pleon has none of the segments fused. The telson is narrower at the base than the preceding segment.

VIII. *Caprella*.—Among the numerous specimens sent to me by Dr. Cunningham, all appear to correspond with Dana's description of *C. dilatata*, except one, which more nearly coincides with *C. robusta*—a circumstance that confirms the opinion expressed in the British-Museum 'Catalogue of Amphipodous Crustacea,' that the two species are but sexually distinct. Dana's specimens, like those of Dr. Cunningham, were brought up with the anchor in Rio Harbour.

EXPLANATION OF PLATE XXI.

Fig. 1. *Idotea annulata*, Dana.

Fig. 2. *Galathea monodon*, Milne-Edwards (young), natural size: c, carapace slightly enlarged; k, first pair of pereopoda.

Fig. 3. *Uca Cunninghami*, n. sp., ♀, nat. size: *P'*, pleon, seen on the outer side; *P''*, the same, inside, *in situ*, showing:—*p*, pleopoda; *v*, young crabs; *z*, termination of intestinal track; *t*, one of the pleopoda.

LI.—On *Eugereon Boeckingi* and the Genealogy of the *Arthropoda*. By Dr. ANTON DOHRN*.

THE *Eugereon* [described and figured by the author in Dunker's 'Palæontographica,' Bd. xiii.] was found in an iron-stone-pit belonging to M. Boecking, near the Abenteuerhütte, in the district of Birkenfeld. The stone containing it is an argillaceous sphærosiderite, which occurs between the carboniferous formation and the Lower New Red Sandstone, and which also contains a number of known Fishes and the celebrated *Archegosaurus*, together with ligneous fibres as the sole vegetable remains. I have lately received from the same pit an admirably preserved impression of the fore wing of a *Blatta*; so that it is to be hoped that the insect-fauna of former ages will be further enriched from this locality. As early as 1856, however, F. Goldenberg described some insects from the Coal-measures of Saarbrück; and still earlier, in 1842, Germar described several species of *Blattina* from the carboniferous rocks of Wettin. Still older discoveries have been made in North America: Samuel Scudder has described two new Neuropterous forms from the Coal-measures of Illinois, *Miamia* and *Hemeristia*, for both of which he requires the establishment of new families, Palæopterina and Hemeristina,—and also, from the still lower Devonian strata of New Brunswick, wings which he identifies as those of Ephemeridæ, but one of them

* Translated by W. S. Dallas, F.L.S., from the 'Stettiner entomologische Zeitung,' Jahrg. xxviii. (1867) pp. 145-158.

as belonging to an insect which must have been precisely intermediate between the Orthoptera and Neuroptera. By this discovery and that of *Eugereon*, important and hitherto quite unsuspected steps have been made towards the establishment of the genealogical relationship of the order of Insects.

As regards *Eugereon*, in order to indicate the position which, in my opinion, it must occupy in the genealogical tree, I will here reproduce the concluding paragraph of my memoir in the 'Palæontographica.'

"If we compare the organization of the recognizable parts of our fossil with living forms of Insects, we arrive at the surprising result that we have to do with an animal which will not enter into any of our orders of Insects hitherto regarded as so firmly established. Not only M. Tischbein, to whose kind intervention I am indebted for the intellectual possession of the animal, but also Dr. Hagen, of Königsberg, to whom I sent it for his inspection and opinion, regarded it as an Hemipteron, the latter, however, with this limitation:— 'Probably it constitutes a perfectly new form, which, on account of the labium, scarcely agrees with the existing Hemiptera, but can only be referred to them.' My own opinion was originally the same; but I am now decidedly of opinion that I have an insect before me to which our divisions do not apply, and which therefore stands outside our system. The wings, especially, prevent my referring it to the Hemiptera. No Hemipteron is destitute of the clavus on the anterior wings; and in none do the longitudinal veins show a tendency to attain the inner margin, but all are directed towards the apex of the wing. Moreover there are no Hemiptera with antennæ resembling those of *Eugereon*. The antennæ of Hemiptera are of several (*i. e.* 4–5) joints, or, if we count all the small intermediate joints (*e. g.* in *Ectrichodia*), of 8–9 joints; but this is the highest number. The form, however, of these joints is essentially different from that of the antennal joints of *Eugereon*. In the Hemiptera they are long, unequal, and here and there furnished with dilatations or other alterations of form; in the latter small and all alike. To this we may add the formation of the buccal organs. The rostrum of the Bugs consists, as is well known, of a nearly closed multiarticulate tube, in which the filiform mandibles and maxillæ are freely moveable. The tube consists of the labium amalgamated with the labial palpi. In *Eugereon* we find all these elements present, but very differently developed. The mandibles and maxillæ are not filiform, nor does the labium form a tube. And yet it is not difficult to regard this structure of the buccal organs as a preliminary step towards the existing Hemipterous

mouth. If we suppose the labial palpi to lay themselves together by their free, smooth, inner margins, and to enclose the jaws within them, we have before us a picture exactly analogous to the rostrum of a Bug. All that would then be necessary is the amalgamation of the two palpi so as to produce the tube, and the gradual conversion of the rather stronger jaws into weaker ones, to attain the formation of the Hemipterous rostrum. The structure of the head, the breadth of the thorax, the form of the legs, which so distinctly remind us of the *Fulgoride*, are, moreover, the clearest indications that we have to do with an animal which is very nearly allied to the Hemiptera. On the other hand, however, the form of the wings, the venation, and the antennæ do not altogether negative a comparison with the Neuroptera; and thus we get as the probable final result that *Eugereon* is to be regarded as a very ancient insect, which indicates a still older progenitor, in which Hemiptera and Neuroptera were still entirely undifferentiated. It would be impossible to regard *Eugereon* itself as this progenitor, because, in the first place, Neuroptera were already in existence along with it, their remains having been found; but, on the other hand, we can hardly fail to see how it would gradually entirely lose the characters of the one order and change and bring to perfection the others alone. It is much more intelligible to regard it as part of an extinct sideline, which had a common progenitor with the Hemiptera and Neuroptera, if, indeed, my view as to the relationship of *Eugereon* with the latter order in the structure of the wings and antennæ should prove correct."

Thus, therefore, we have in *Eugereon* an animal which again demonstrates with extraordinary distinctness the truth of the Darwinian theory, and does its part in assisting to throw a little more light upon the principles of morphological science. It was to be expected, and, indeed, was regarded as certain by all unprejudiced naturalists, that morphology in general would undergo a powerful shock and a complete revolution by means of the Darwinian theory, and that a gigantic step would have to be made in this science. Already, before any one could have expected such a thing, this gigantic step has been made by Hæckel, the celebrated zoologist of the University of Jena. In his work on the general morphology of organisms* are laid down the principles of a new science, Morphology. I shall have occasion elsewhere to refer fully to the wide significance of this work, and its extremely rich and many-sided contents; here I will only extract one thing, namely, the

* *Generelle Morphologie der Organismen*, von Ernst Hæckel. 2 vols. Berlin, 1866.

genealogical tree of the Arthropoda, which must possess a special interest for the readers of this journal.

Häckel derives the Vermes and Arthropoda from a common root, which stood in genetic connexion with the Infusoria, and from which the Rotatoria have also originated. The Arthropoda then divide into two large sections (*Cladus*):—the *Carides*, Crustacea (Branchiferous Arthropoda); and the *Tracheata*, Insects (Tracheiferous Arthropoda). Häckel very correctly justifies this division by saying that the orders of Arachnida, Myriopoda, and Insecta are more closely connected than certain families of the Crustacea; and it seems pretty certain that the Tracheata were only developed from the Carides. Palæontology, indeed, furnishes but little evidence upon this point; but more is offered by the developmental history of individuals; and it is well known that the larvæ of certain Neuroptera for a long time retain branchial respiration, which they only subsequently exchange for tracheal respiration. As, however, it is to be regarded as an established law that the development of an animal in the egg and in the larval state (the *ontogenetic* development) is only an abridged and partially obscured picture of the development of a genealogical tree (the *phyletic* development), we are justified (as also for many other reasons) in drawing this far-reaching conclusion as to descent from so remarkable a phenomenon as the change in the mode of respiration in the larvæ of Neuroptera. Hence, also, developmental history, the study of which has now been taken up with fresh vigour, acquires an extraordinary importance; and it is to be hoped that the necessary aid will not be denied on the part of entomologists: and this will consist essentially in their undertaking a description and systematization of the larvæ as well as the description and classification of the perfectly developed insects, and in ascertaining by observation the external changes which the body of the larva undergoes until it becomes transformed into the perfect insect.

I will not enter into the details of the development and descent of the Crustacea, but only refer to the hypothetical order of the *Zoëpoda*, which, according to the concordant opinions of Fritz Müller and Häckel, included the progenitors of the Schizopoda (*Mysis*, *Euphausia*), and consequently of the Stomatopoda, Decapoda, and all the Edriophthalma originating from these, as also of the Tracheata. The assumption of this order is founded upon the *Zoëa*, so well known to all crustaceologists, a developmental form in the ontogenesis of most Podophthalma, which refers us back to the *Zoëpoda*. The unknown common original form of the Arachnida, Myrio-

poda, and Insecta must have been a Zoëpod, which accustomed itself to living on the land and to direct aërial respiration, and thus gradually, in the course of a long series of generations, acquired the very characteristic tracheal respiration. It must have been developed in the time between the Silurian and Carboniferous periods; for in the Silurian period there were as yet (at least so far as we know at present) no terrestrial organisms, but in the Carboniferous period, and even in the Devonian (according to the most recent publications of S. Scudder), the earliest developed Tracheata, both Insects and Arachnida, had already made their appearance.

The primitive forms of the three sections Arachnida, Myriopoda, and Insecta, as to which we can now only form analogical conclusions, are named *Protracheata* (*Urkerfe*, Primitive Insects) by Hæckel, who characterizes them as follows:—“Of these primitive forms of the Tracheata, developed from the Zoëpoda between the Silurian and Carboniferous periods, no fossil remains are known to us. Nevertheless the comparative ontogeny of the Malacostraca, Arachnida, Myriopoda, and Insecta enables us to arrive, with tolerable certainty, at definite conclusions as to their form. Like many Zoëpoda (which are still preserved to us in *Zoëa*-states) and like the true insects, between which they occupy an intermediate position, the Protracheata, as the type of which we may establish the hypothetical genus *Zoentomon*, must have possessed three pairs of jaws and three pairs of locomotive extremities. From these hexapod Zoentomidæ, in all probability, the Insecta have been developed as the direct branch, and the Arachnida as a weaker lateral branch. The Myriopoda constitute only an inconsiderable lateral branchlet of the Insecta. Whether any Protracheata are still in existence is doubtful. The *Solifugæ* might, perhaps, be placed in this category, and perhaps also those ‘apterous insects’ (if there be any such among existing insects) in which the want of wings is *aboriginal*, and has not been *acquired* by adaptation.”

The Arachnida I likewise leave out of the question here, and will only mention the one highly remarkable form which alone in this class has still retained the old type, and which allows us to arrive at a certain conclusion as to the original community of ancestry of the Insecta and Arachnida—that of the *Solifugæ*. In this family we find no amalgamation of the head and thoracic segments to form a cephalothorax, but three perfectly separated regions of the body—head, thorax, and abdomen. The head bears the pair of eyes, the pair of antennæ, and two pairs of maxillary palpi. The three segments of the thorax bear the three pairs of true legs. The abdomen,

which is destitute of appendages, is composed of ten segments. By the fusion of the head and three thoracic segments we get the primary form of the *Arthrogastres* (Scorpions, &c.), and by the further fusion of the abdominal segments into one piece the *Sphærogastres* (true Spiders).

The Myriopoda have broken out from some early insectan branch. This is clearly shown by their embryonal form and development; for the embryos possess only three pairs of legs, and perfectly resemble larvæ of insects. Moreover the internal anatomy of the Myriopoda is so nearly related to that of insects that there can be no doubt of the fact of their derivation. The great number of body-segments, and consequently of legs, is a subsequent addition, acquired after the branching off, as is proved by their development, and is also shown by the analogy of many Crustacea (*Edriophthalma*).

Thus we come to the true Insecta. Here, following the example of Fritz Müller and Häckel, we must in the first place dispose of a strong prejudice, namely, the principle of classification according to the "complete" or "incomplete" metamorphosis. This is now-a-days a perfectly untenable principle. We now know not only what is the significance of metamorphosis in general and what we are to conclude therefrom, but we have also learnt, thanks to the brilliant investigations of Fritz Müller upon the Crustacea, what modalities may affect the metamorphosis, lengthening, abridging, or altering it; and we know that the so-called "perfect" metamorphosis of many, and perhaps of all insects, has been *acquired* during ontogenesis (and not *inherited* from the original progenitor). Moreover we have obtained from the facts the abstraction that the metamorphosis is always abridged in proportion as more generations follow one another, and that the tendency of the organisms (if we may use the expression) is always striving to attain, by the shortest possible way, from the egg state to the perfect, sexually mature animal. For this reason I have already indicated how important, and how rich in unexpected results, a comparative investigation of larvæ will be. One of the most striking examples of a perfect difference of metamorphosis, with the greatest similarity in its starting and finishing points (the egg and the sexually mature animal), is presented by a species of the genus *Gecarcinus*, a Brachyurous Crustacean which, like the Crayfish, quits the egg at once in its definitive form, whilst all other crabs, and even all other species of the genus *Gecarcinus*, only attain their definitive form after passing through a metamorphosis. Similar peculiarities will certainly be presented to us by a careful investigation of larvæ, and the notions of complete and

incomplete metamorphosis will not hold their ground against a sharper examination and criticism of the facts.

Häckel has also entirely given up this principle of division, and retained instead of it the form of the buccal organs, so far as they are arranged either for biting or sucking. Whether this is a permanent principle must be shown hereafter, when more means of observation may be employed than at present. Discoveries like *Eugereon*, in a palæontological direction, and the larva of *Sisyra* (described by Westwood as *Branchiotoma Spongillæ*, see Gerstäcker and Carus, 'Zoologie,' p. 73), which, as I have been informed by Professor Grube, and also find repeated in Gerstäcker's 'Handbuch,' likewise has a sucking buccal apparatus, although its imago belongs to the Neuroptera, are certainly adapted to render the certainty of this mode of division somewhat doubtful. However, it is of no consequence whether or not there is such a principle of division; when we have a knowledge of the ontogenetic and phylogenetic development we can subsequently select any principle we like, and employ it for the sake of convenience. For the present we must adhere to Häckel's classification. Häckel is of opinion that the first Protracheate (belonging to the hypothetically adopted family produced from the Zoëpoda, but which still united in itself the germs of the Insecta, Arachnida, and Myriopoda), which possessed two developed pairs of wings, is to be regarded as the common progenitor of all the living and fossil insects known to us, as the apterous forms undoubtedly all (?) originate from winged ancestors, and have lost their wings by adaptation and secondary generation. The development of this progenitor falls in the interval between the Silurian and Carboniferous periods, and probably in the ante-Devonian period; for we have insects from the Devonian as well as from the coal, and these are exclusively *Masticantia* (Orthoptera, Neuroptera, Coleoptera). These Häckel regards as the oldest insects, in opposition to the *Sugentia*, which have branched off from the *Masticantia*; and this is certainly probable when we glance at the ontogenesis of the former. The *Masticantia* he divides into three orders:—*Toroptera*, *Coleoptera*, and *Hymenoptera*. The *Toroptera* are the scarcest, and combine the *Pseudo-Neuroptera*, *Neuroptera*, and *Orthoptera*, which are very nearly allied to each other in many respects, and were formerly only separated by the metamorphosis. As, however, the systematic value of the metamorphosis, as a means of division, has been diminished, these former orders are certainly justly united. Häckel thinks that the Orthoptera and Neuroptera have been developed from the *Pseudo-Neuroptera*—an opinion which obtains a foundation of

fact by the discovery, in the Devonian strata of New Brunswick already mentioned, of an organism uniting the characters of both orders. With regard to the Coleoptera, he assumes that they were developed from the Orthoptera, and the Hymenoptera from the Neuroptera or Pseudo-Neuroptera.

The *Sugentia*, again, include three divisions:—*Hemiptera*, *Diptera*, and *Lepidoptera*. All these, Hæckel supposes, originated from the Toroptera later than the Coleoptera and Hymenoptera, as their first palæontological traces are derived only from the Jurassic strata. The knowledge of *Eugereon*, however, on the other hand, makes him think it not improbable that the Hemiptera diverged from the Toroptera as early as the Primary periods. The origin of the Diptera and Lepidoptera he leaves in doubt, as, in consequence of the segregation (*Abgeschlossenheit*) of these two orders, no conclusions can be derived from probabilities about them.

With this I conclude my report upon this part of Hæckel's remarkable book. I hope soon to be able to make some communications upon special embryological investigations and their general results, as this department is now being worked on several hands with particular predilection. At any rate, however, the satisfactory fact is to be proved that entomology, as well as morphology in general, has acquired a new and fruitful impulse from the Darwinian reform, and that it will be the fault of entomologists themselves if they do not assist in the construction of the new road.

LII.—On some additional Species of the Genus *Eutoxeres*.
By J. GOULD, F.R.S. &c.

I HAVE for some time past had reason to believe that the Humming-birds of this highly singular form comprised more species than the two already described (*Eutoxeres aquila* and *E. Condamini*); but it is only of late that I have acquired sufficient materials to justify my arriving at any satisfactory conclusion on the subject. At this moment I have before me three specimens of the true *E. aquila* from New Granada, seven skins of a bird from the neighbourhood of Quito, which I consider to be distinct from that species, and three from Veragua, which differ slightly from both.

E. aquila is the largest species of the genus, and is distinguished by the snow-white shafts of its tail-feathers, which doubtless show very conspicuously when the bird is on the wing and the tail widely spread; this character is found in every specimen I have examined, and, I believe, will prove

constant. The Quitan bird, like some of the *Phaethorni*, is extremely variable in its markings: for instance, the tail, in some specimens, has the tips of the feathers white for nearly half an inch from the tip, in others for a quarter, in others, again, for an eighth; and I possess one in which the white tipping is absent, all the feathers being of a uniform olive-grey: but in no instance that I have seen does the white extend down the shaft as in *E. aquila*. On comparing the seven Quitan specimens with the Bogotan birds, I find that the stræ on the breast are black and white in the former and black and buff in the latter. I shall designate the Quitan bird *E. heterura*, with the following description:—

Upper mandible wholly black, under mandible yellow for two-thirds of its length from the base, the remainder olive-brown; crown of the head nearly black, each feather glossed with green at the tip; upper surface dull grass-green; tail olive-grey, in some instances tipped with sullied white; wings deep purplish black; under surface, from the throat to the vent, striated with black and buff, the buff becoming lighter on the centre of the abdomen; under tail-coverts brown, varied with black.

Total length 5 inches, bill 1, wing $2\frac{1}{2}$, tail $2\frac{1}{4}$, tarsi $\frac{1}{4}$.

Hab. Ecuador.

The Veraguan bird is much more nearly allied to the Ecuadorian than the New-Granadian species, but possesses characters differing from both, and which, though slight, appear to be constant, none of the specimens I possess having the pure-white shafts of the New-Granadian *E. aquila*, or the uniformly-coloured tail of the Ecuadorian *E. heterura*, but having all the tail-feathers tipped with white; it moreover assimilates to this bird in size, as it also does in the buff colouring of the stræ of the throat and breast. For this Veraguan bird I propose the name of *Eutoxeres Salvini*, in compliment to a gentleman who assuredly deserves that a finer bird should bear his name; but as this species lives on that side of the Isthmus of Panama his labours whereon have been rewarded with such fruitful results, I embrace the first opportunity afforded me of testifying to the benefit he has conferred upon the branch of science to which we are both attached. It may be asked, and with some show of reason, if characterizing birds as distinct which present such trifling differences is not like splitting straws? to which I would answer, such differences not only exist but are as constant as the seasons which run their courses without variation, and it is well known to all who have studied the natural productions of the two Americas that their faunas, with but few excep-

tions, differ *in toto*. How these differences have been brought about is beyond our comprehension; but when we do find them, they ought assuredly to be made known.

The three species of *Eutoxeres* above described are on a par with *Phaëthornis Guyi*, *P. Emilia*, and *P. yaruqui*, which every one now regards as distinct. Sufficient has been said to point out the specific peculiarities of *E. aquila*, *E. heterura*, and *E. Salvini*; it is therefore unnecessary to give a description of the latter.

The species of the genus *Eutoxeres* now known are:—

Eutoxeres Condamini. Habitat Archidona in Eastern Ecuador.

— *heterura*. Hab. Central Ecuador.

— *aquila*. Hab. New Granada.

— *Salvini*. Hab. Veragua and Costa Rica.

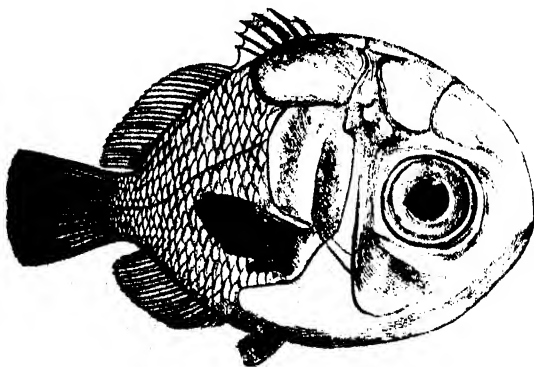
LIII.—*Additions to the Ichthyological Fauna of Zanzibar.*

By Dr. A. GÜNTHER, F.R.S.

DR. KIRK has lately sent a collection of Fishes from Zanzibar to the British Museum; it contained the following new forms (besides several others previously not known to exist on that coast, viz. *Dules Bennettii*, *Rhynchichthys pelamidis*, *Brama orcini*, *Eleotris madagascariensis*, *El. fusca*, *Chromis mossambica*, *Exocætus nigripinnis*):—

Tholichthys osseus.

I propose this name for a fish which, although young, is



(Six times the natural size.)

evidently the type of a new genus, and appears to belong to
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the Scombroïd group *Cyttina*. I am well aware that the young of numerous Scombroïd and Carangoid fishes are provided with an armature of the head which disappears with age, and I have but little doubt that the appearance of this fish also is different in old individuals; but I do not think that the osseous plates behind the head disappear; and they will form the character by which the fish may be recognized at all ages. Having only a single example, 11 millims. long, I must omit the description of several characters, as the dentition, gills, &c.

Body compressed, suborbicular, the greatest depth being contained once and one-third in the length (without caudal); head enormous, the root of the ventral fin being considerably nearer to the base of the caudal than to the anterior profile of the head; eye very large, situated nearly in the middle of the depth of the head, and nearer to the end of the snout than to that of the operculum. Mouth extremely small, opposite to the lower part of the eye. The entire head is covered by bone; and several of the bones are much enlarged, so as to cover the anterior part of the trunk; there is an ovate suprascapular plate covering the back below the first dorsal fin, and a humeral plate between it and the ventral. Both these plates are attached to the skin of the body in their basal portion only. The præopercular angle is much dilated and produced backwards into a very large subtriangular process, which is rounded behind, extending nearly to the anal.

The remainder of the body is covered by scales, which are of moderate size and much deeper than long.

There are two dorsal fins; the first, composed of six spines (which are of moderate strength and short), is much less developed than the second, which is formed by twenty-two rays. Anal fin corresponding in size and position to the soft dorsal, with twenty rays. Caudal subtruncated. Pectoral moderately developed. Ventrals thoracic, with one spine and five rays.

Salarias Kirkii.

Allied to *Salarias tridactylus*.

D. $\frac{16}{24}$. A. 28.

The height of the body is rather less than the length of the head, which is nearly one-seventh of the total length (without caudal). The single specimen obtained has a triangular crest on the head, tapering into a point; a very small fringed tentacle above the orbit. The dorsal fin is slightly emarginate, the anterior dorsal spines being as long as the posterior rays; the

last dorsal ray connected by membrane with the root of the caudal. Canine teeth none.

Dark blackish olive, with scarcely a trace of lighter or darker bands on the body. Dorsal fin with very indistinct whitish oblique lines; anal fin with a broad black margin.

A single specimen, $3\frac{1}{2}$ inches long.

Exocætus melanopus.

D. 14. A. 13.

Mandible with a long black band-like appendage, bifid at the end and nearly extending to the end of the head. The height of the body is one-fourth of the total length (without caudal); the length of the head is contained thrice and three-fourths in it. Head nearly as deep as long, broad in its nuchal portion, and compressed in the rostral; snout obtuse and very short, one-half the length of the diameter of the eye, which is more than one-third of the length of the head. Pectoral fin extending beyond the root of the caudal. Root of the ventrals nearer to the end of the snout than to the base of the caudal; and they extend somewhat beyond the origin of the anal. The dorsal fin commences nearly opposite to the first anal ray. Trunk and tail with three blackish cross bands, the first corresponding to the space between ventrals and anal; pectoral uniform white, black at the base; ventrals deep black; caudal white.

One specimen, 2 inches long.

LIV.—On the Species of Helicidæ found in Japan.

By ARTHUR ADAMS, F.L.S.

THE following systematic list of inoperculate Pulmonifera which live upon the land contains notices of species collected by myself in Japan. It is doubtless very imperfect, because the interior of these beautiful islands has never yet been explored by naturalists. Newcombe (Proc. Cal. Acad. Nat. Sc. 1865) has described two species of *Helix* (*H. Blakeana* and *H. declivis*) and one species of *Succinea* (*S. japonica*) which I have not seen. Von Martens has made mention of *Helix* (*Ægista*) *Friedeliana* and *Stenogyra* (*Opeas*) *javanica*, Rve.; but I am not acquainted with either of these species. *Opeas juncea* of Gould has also been said to inhabit Japan; but I believe my *Opeas pyrgula* has been mistaken for that species. I obtained examples of *Helix* (*Plectotropis*) *Mackensii*, Val., at Cone Island, and specimens of *Helix* (*Plectotropis*) *ciliosa*,

Pfr., at Port Hamilton; but these localities belong to the Korean archipelago, which I have not included in my enumeration of Japanese Mollusca. *Helix (Plectotropis) elegantissima*, Pfr., is stated to have come from Japan; but I never met with that charming shell during my explorations.

In a future communication I shall examine the remainder of my Japanese Helicidæ, comprising the subfamily *Pupinæ*.

Fam. Philomycidæ.

Genus PHILOMYCUS, Rafin.

Philomycus bilineatus, Cantor.

Incillaria bilineata, Cantor, Bena. Ann. & Mag. Nat. Hist. 1842.

Hab. Takano-Sima, Sado, Tabu-Sima, Tago.

Fam. Limacidæ.

Genus LIMAX, Linn.

Limax varians, A. Ad.

L. corpore elongato, postice subcarinato, sordide albo, interdum nigro, nunquam variegato; clypeo elongato, concentricè rugoso; foramine antico; tentaculis attenuatis, elongatis.

Long. $1\frac{1}{2}$ poll.

Hab. Hakodadi, Rifunsiri, Risiri.

The only true slugs I have noticed. They are either white or black, and belong, I believe, to the same species. May be var. of *L. agrestis*, Linn.

Fam. Helicidæ.

Subfam. SUCCININÆ.

Genus SUCCINEA, Draparn.

1. *Succinea lauta*, Gould.

? *S. japonica*, Newc.

Hab. Hakodadi, Vladimир.

2. *Succinea putris*, Linn.

Hab. Olga Bay, Vladimир Bay.

Subfam. HELICINÆ.

Genus HELIX, Linn.

1. *Helix (Acusta) Sieboldiana*, Pfr.

Hab. Tsus-Sima, Sado, Mososeki.

2. *Helix (Acusta) lata*, Gould.

Hab. Matsumai, Hakodadi.

3. *Helix (Acusta) conospira*, Pfr.

Hab. Nangasaki, Yeddo (Martens).

4. *Helix (Camena) quærita*, Desh.

Hab. Simoda, Tabu-Sima, Sado.

5. *Helix (Camena) peliomphala*, Pfr.

Hab. Mososeki, Tago.

6. *Helix (Camena) luchuana*, Sow.

Hab. Dagelet Island.

7. *Helix (Camena) Simodæ*, Jay.

H. Herklotsi, Martens.

Hab. Simoda, Vladimir Bay, Olga Bay.

8. *Helix (Camena) myomphala*, Martens.

H. daimio, A. Ad.

Hab. Tago.

9. *Helix (Camena) orientalis*, Ad. & Rve.

H. germana, Rve.

Hab. Nangasaki, Mososeki, Tsus-Sima.

10. *Helix (Camena) pyrrhozona*, Phil.

Hab. Hakodadi, Olga Bay, Vladimir Bay.

11. *Helix (Camena) miranda*, A. Ad.

H. testa depresso-globosa, lato perforata; spira turbinata, elatiuscula, apice obtusa; anfract. 6, convexis, strigis obliquis conspicuis et striis volventibus confertis decussatis; anfractu ultimo ad peripheriam rotundato, ad basim convexo; apertura obliqua, lunata; peristomate expanso, reflexo, intus incrassato. Straminea, fascia rubro-fusca ad peripheriam et ad suturas ornata.

Lat. 1 poll. 3 lin., alt. 9 lin.

Hab. Rifunsiri Island.

A handsome species, of a deep straw-colour, adorned with a red-brown band at the periphery and another at the suture. I found several specimens adhering to the stems of a gigantic species of *Archangelica*, in the little island of Rifunsiri, near the Straits of La Perouse.

12. *Helix (Camena) serotina*, A. Ad.

H. testa subglobosa, lato perforata; spira elato-turbinata, apice obtusa; anfract. 6, convexis, oblique strigatis (strigis inæqualibus) et striis minutissimis volventibus confertis decussatis; basi convexa; apertura lunata; peristomate expanso, reflexo, intus albo,

incrassato, ad umbilicum dilatato. Serotina vel straminea, interdum fascia transversa rufo-fusca ornata.

Lat. 9 lin., alt. 7 lin.

Hab. Sagaleen, near Cape Notoro.

A pretty species, orange- or deep straw-coloured, very much resembling in general appearance the bright-yellow varieties of *Helix hortensis*. I found it living in the dense thickets of bamboo near the shore.

13. *Helix (Camena) Editha*, A. Ad.

H. testa depresso-conoidali, late perforata; spira elatiuscula, obtusa, apice obtusa; anfract. 6, convexiusculis, oblique strigosis et striis volventibus confertis decussatis; anfractu ultimo ad peripheriam rotundato, ad basim planiusculo; apertura obliqua, lunata; peristomate subexpanso, reflexo, intus vix incrassato. Albida, fasciis duabus rubro-fuscis in anfractu ultimo et fascia unica ad suturas ornata.

Lat. 8½ lin., alt. 4 lin.

Hab. Risiri Island, Vladimir Bay.

This species resembles in general appearance *H. pyrrhona* of Philippi; but the spire is more elevated, and the outline of the shell is more conoidal.

14. *Helix (Fruticicola) similaris*, Fér.

Hab. Kino-O-Sima, Simoda.

15. *Helix (Fruticicola) textrina*, Bens.

Hab. Tago.

16. *Helix (Fruticicola) genulabris*, Martens.

Hab. Nangasaki.

17. *Helix (Fruticicola) japonica*, Pfr.

Hab. Tabu-Sima, Matsumai.

18. *Helix (Fruticicola) Stimpsoni*, Pfr.

Hab. Simonoseki.

19. *Helix (Fruticicola) patruelis*, A. Ad.

H. testa globoso-conoidali, perforata; spira elata, turbinata; anfract. 7, planiusculis, oblique striatis et striis subtilissimis confertis volventibus decussatis; anfractu ultimo ad peripheriam obtuse angulato, ad basim planiusculo; apertura oblique lunata; peristomate expanso, reflexo. Luteo-cornea, interdum fascia transversa pallida ad peripheriam ornata.

Lat. 8 lin., alt. 6½ lin.

Hab. Tabu-Sima.

Very similar in general appearance to *H. japonica*, Pfr., but more conoidal, and with the periphery more decidedly angulate. It is also a smaller and thinner shell.

20. *Helix (Fruticicola) peculiaris*, A. Ad.

H. testa globoso-conoidali, anguste perforata, tenui, luteo-cornea; spira turbinata, modica, apice obtusa; anfract. 6, convexis, oblique striatis et striis volventibus subtilissimo decussatis; anfractu ultimo ad peripheriam rotundato, antice deflexo et constricto, basi convexo; apertura perobliqua, lunata; peristomate expanso, reflexo, ad basim rectiusculo et callo vix elato instructo, ad umbilicem late reflexo.

Lat. 6 lin., alt. $6\frac{1}{2}$ lin.

Hab. Tanabe.

H. japonica, *H. patruelis*, and the present species form a group which seems peculiar to Japan, and which is characterized by the conoidal form of the shell, by the base being more or less flattened, and by the straight horizontal basal portion of the peritreme. To this section may be assigned the name *Satsuma*.

21. *Helix (Fruticicola) gibbosa*, A. Ad.

H. testa depresso-globosa, tenui, perforata; spira parva, conoidali, apice acuta; anfract. 6, convexiusculis, striis incrementi et volventibus minutis decussatis; anfractu penultimo gibboso, ultimo subinflato ad peripheriam rotundato, antice deflexo; apertura obliqua, lunata; peristomate expanso, breviter reflexo. Albido-cornea.

Lat. $6\frac{1}{2}$ lin., alt. 5 lin.

Hab. Tanabe.

A species remarkable for the sudden deflection of the last whorl anteriorly, which produces a gibbose appearance of the penultimate whorl. The peristome on the left side is broadly reflexed, and nearly covers the umbilicus.

22. *Helix (Fruticicola) sphinctostoma*, A. Ad.

H. testa globoso-conica, anguste perforata; spira conoidali; anfract. 6, convexis, oblique striatis, ultimo ad peripheriam rotundato, ad aperturam valde constricto; apertura perobliqua, lunata; peristomate albilabiato, late expanso, reflexo. Lutescenti-cornea.

Lat. 6 lin., alt. 5 lin.

Hab. Tago.

A species remarkable for the constriction of the last whorl just behind the aperture, and with the peristome white, expanded, and reflexed.

23. *Helix (Fruticicola) Collinsoni*, A. Ad.

H. testa globoso-conica, late perforata, tenui; spira elata conoidali; anfract. 6, convexiusculis, oblique striatis, creberrime transversim striatis, anfractu ultimo ad peripheriam rotundato; apertura obliqua, lunata; peristomate subexpanso, breviter reflexo. Albido-cornea, fascia lata ad suturas et ad peripheriam ornata.

Lat. $5\frac{1}{2}$ lin., alt. 3 lin.

Hab. Tago.

A pretty, fragile species, somewhat conoidal, and adorned with a spiral red-brown band.

24. *Helix (Fruticicola) commoda*, A. Ad.

H. testa globoso-conoidali, late perforata, tenui, corneo-rufescente; spira obtusim conica, elata; anfract. 5, convexis, oblique striatis, ultimo ad peripheriam rotundato; apertura orbiculato-lunata; peristomate breviter reflexo.

Lat. 3 lin., alt $2\frac{1}{2}$ lin.

Hab. Mososeki.

A very neat and pretty little species, of a reddish horn-colour, and with a conoidal spire and rounded whorls.

25. *Helix (Fruticicola) despectu*, A. Ad.

H. testa depresso-conoidali, perforata, tenui, cornea, fusca, subtilissime oblique striata; spira conica; anfract. 4, planiusculis, ultimo ad peripheriam angulato; apertura angulatim lunata, peristomate recto, acuto, ad umbilicum breviter reflexo.

Lat. 3 lin., alt. $2\frac{1}{2}$ lin.

Hab. Mososeki.

A small, thin, horn-coloured species, with angular periphery, found on the foliage of plants at Mososeki, a village on the Straits of Simonoseki.

26. *Helix (Fruticicola) craspedocheila*, A. Ad.

H. testa depresso-conica, late perforata, albido-cornea; spira vix elata, apice obtusa; anfract. 5, convexiusculis, striis incrementi et volventibus decussatis; apertura perobliqua, lunata; peristomate rectiusculo, infra reflexo, intus albo, incrassato, ad basim callo instructo.

Lat. $4\frac{1}{2}$ lin., alt. 3 lin.

Hab. Kino-O-Sima.

A depressed species, with the peritreme internally thickened, and with a slightly elevated callus at the basal portion.

27. *Helix (Fruticicola) proba*, A. Ad.

H. testa orbiculato-depressa, late umbilicata, rufo-fusca, oblique striata; spira vix elata; anfract. 6, planiusculis, ultimo ad peri-

peripheriam obtusim subangulato; apertura rotundato-lunata, perobliqua; peristomate breviter reflexo, ad basim regulariter arcuato.

Lat. 5 lin., alt. $2\frac{1}{2}$ lin.

Hab. Kino-O-Sima.

This species resembles somewhat in form and colour *H. Stimpsoni*, Pfr.; but it is more depressed, the umbilicus is wide and perspective, and the peritreme has not the peculiar bend seen in *H. genulabris* and *H. Stimpsoni*.

28. *Helix (Fruticicola) concinna*, A. Ad.

H. testa orbiculato-depressa, rufo-cornea, tenui, perforata, umbilico modico, oblique strigosa, striis volventibus conspicuis decussata; spira obtusa, elatiuscula; anfract. 5, convexiusculis, ultimo ad peripheriam rotundato; apertura lunata; peristomate recto, acuto, ad umbilicum reflexo.

Long. 6 lin., alt. 4 lin.

Hab. Tago.

A thin light-horncoloured species, with the revolving striæ very distinct, and with the peritreme sharp-edged.

29. *Helix (Ægista) Friedeliana*, Martens.

Hab. Nangasaki (Martens).

I do not know this species.

30. *Helix (Plectotropis) ciliosa*, Pfr.

Hab. Tsus-Sima, Awa-Sima, Tabu-Sima.

31. *Helix (Plectotropis) squarrosa*, Gld.

Hab. Kino-O-Sima, Tsus-Sima, Tsaulian.

32. *Helix (Plectotropis) conella*, A. Ad.

H. testa orbiculato-conica; spira depressa, umbilico modico, perforata, ochraceo-cornea, tenui, squarrosa, oblique valde strigosa; epidermide in lineis interruptis obliquis disposita; anfract. 6, planis, ultimo ad peripheriam acute carinato, basi convexo; peristomate acuto, expanso, et breviter reflexo.

Lat. 5 lin., alt. 3 lin.

Hab. Tabu-Sima.

Most like *H. squarrosa*, Gld., in colour and surface, which is scabrous and scaly; but the periphery, instead of being rounded, is acutely keeled; and the umbilicus, instead of being large and deep, is moderate.

33. *Helix (Plectotropis) setocincta*, A. Ad.

H. testa orbiculato-conica; spira depressa, umbilico lato et profundo

perforata, tenui, rufo-fusca, oblique striata; epidermide in lineis elevatis radiantibus disposita, ad peripheriam in ciliis modicis producta; anfract. 6, planis, ultimo ad peripheriam acute angulato, basi convexo; apertura obliqua, lunata; peristomate recto, acuto.
Lat. 6 lin., alt. 3 lin.

Hab. Sado, Awa-Sima.

Most like *H. ciliosa*, Pfr.; but the outline is more conical, and the epidermis at the periphery is developed into longer hair-like projections than in that species.

34. *Helix (Plectotropis) trochula*, A. Ad.

H. testa orbiculato-conica; spira elata, umbilico lato et profundo perforata, tenui, rufo-fusca; epidermide in lineis obliquis interruptis disposita, ad peripheriam in ciliis brevibus producta; anfract. 6, planis, ultimo ad peripheriam acute angulato, basi convexo; apertura obliqua, lunata; peristomate acuto, expanso, breviter reflexo.

Lat. $6\frac{1}{2}$ lin., alt. 4 lin.

Hab. Tsus-Sima.

A larger and more conoidal species than *H. setocincta*, and with the epidermis forming raised, radiating, but interrupted lines, and with the ciliary fringe at the periphery much shorter.

35. *Helix (Plectotropis) scabricula*, A. Ad.

H. testa orbiculato-conoidali, late umbilicata, ochraceo-cornea, squarrosa; spira depresso-conica; anfract. $6\frac{1}{2}$, convexiusculis, ad peripheriam subangulatis; epidermide in squamulis elongatis, radiatim dispositis producta; apertura parva, angusta, lunata; peristomate breviter reflexo.

Lat. $4\frac{1}{2}$ lin., alt. 3 lin.

Hab. Awa-Sima.

Of the same form and with the same rough scaly surface as *H. squarrosa*, only smaller and with a more elevated spire and narrower umbilicus.

36. *Helix (Patula) paupera*, Gould.

Hab. Matsumai, Hakodadi, Olga Bay.

37. *Helix (Patula) elatior*, A. Ad.

H. testa orbiculato-conica, oblique costulata, late umbilicata; spira conica, elatiuscula; anfract. $4\frac{1}{2}$, planis, ad suturas marginatis, ultimo ad peripheriam acute carinato; apertura perobliqua, rotundato-lunata; peristomate simplici, acuto.

Lat. $3\frac{1}{2}$ lin., alt. 2 lin.

Hab. Dagelet Island.

A larger and more conical species than *H. paupera*, Gould,

with the whorls flat, the last acutely keeled, and with the sutures margined. Found under bark of dead trees in the little island of Dagelet, in the Sea of Japan.

38. *Helix (Patula) depressa*, A. Ad.

H. testa discoideo-conica, late umbilicata, rufo-cornea, oblique costellata; spira depresso-conica; anfract. $4\frac{1}{2}$, planis, ultimo ad peripheriam acute angulato; apertura perobliqua, anguste lunata; peristomate simplici, acuto.

Lat. 3 lin., alt. 1 lin.

Hab. Vladimir Bay.

A small, depressed species, with the whorls very finely obliquely ribbed, and with the last whorl acutely angulated at the periphery.

Subfam. VITRININÆ.

Gen. HYALINA, Fér.

1. *Hyalina? nitida*, Mill.

Hab. Tsus-Sima.

2. *Hyalina? electrina*, Gld.

Hab. Kino-O-Sima.

3. *Hyalina (Pseudohyalina) minuscula*, Binney.

Hab. Vladimir Bay.

4. *Hyalina (Microcystis) rejecta*, Pfr.

Hab. Tsus-Sima.

5. *Hyalina (Microcystis) labilis*, Gld.

Hab. Hakodadi.

6. *Hyalina (Conulus) pupula*, Gld.

Hab. Hakodadi (Stps.), Vladimir Bay (A. Ad.).

This is the species most probably mentioned by Middendorff as *H. chersina*, Say, in which, however, the whorls are narrower and more numerous.

7. *Hyalina (Conulus) phyllophila*, A. Ad.

H. testa subglobo-conica, imperforata, nitida, tenui, oblique striata, pellucida, succinea; spira elata, conica; anfract. $5\frac{1}{2}$, planis, ultimo ad peripheriam obtuse angulato, basi convexo; apertura rotundato-lunata.

Lat. 2 lin., alt. 2 lin.

Hab. Mososeki.

A thin, imperforate, turbinate, amber-coloured species, with

the spire elevated and the last whorl rounded. I found it at the Straits of Simonoseki, adhering to the leaves of trees in the vicinity of the village of Mososeki.

8. *Hyalina (Conulus) incerta*, A. Ad.

H. testa globoso-conica, anguste perforata, corneo-fusca, tenui, oblique tenuiter striata; spira conica, elata; anfract. $4\frac{1}{2}$; planis, ultimo ad peripheriam obtuse angulato; apertura angulato-lunata; columella ad umbilicum breviter reflexa.

Lat. $1\frac{1}{2}$ lin., alt. $1\frac{1}{4}$ lin.

Hab. Tabu-Sima.

This may be an immature shell; but I know of no species from Japan to which it can be referred.

9. *Hyalina (Conulus) tenera*, A. Ad.

H. testa orbiculato-conica, imperforata, tenui, pellucida, luteo-cornea; spira conoidali, convexa, apice obtusa; anfract. 6, planis, oblique striatis, ultimo ad peripheriam acute carinato, basi nitido, convexo; apertura obliqua, lunata; columella ad umbilicum sub-reflexa.

Lat. 3 lin., alt. 2 lin.

Hab. Matsumai, Straits of Tsugar.

A depressly conical thin species, with no very marked characters, except its size, to distinguish it from others belonging to the same group. I found it among dead leaves in damp situations.

10. *Hyalina (Conulus) stenogyra*, A. Ad.

H. testa globoso-conoidali, tenui, imperforata, succinea, pellucida; spira conica, elata, convexa, apice obtusa; anfract. $9\frac{1}{2}$, planis, angustis, oblique striatis, ultimo ad peripheriam acute carinato, basi convexo, glabro; apertura obliqua, anguste lunata.

Lat. $1\frac{1}{2}$ lin., alt. $1\frac{1}{4}$ lin.

Hab. Tsus-Sima.

This is a very pretty little beehive-shaped, transparent, amber-coloured shell, with numerous narrow whorls. I found it, in considerable numbers, crawling over dead leaves in the woods.

11. *Hyalina (Conulus) acutangula*, A. Ad.

H. testa conoidali, imperforata, tenui, succinea; spira elata, conica, convexiuscula; anfract. $5\frac{1}{2}$, planis, oblique tenuissime striatis, ultimo ad peripheriam acute carinato, basi glabro planiusculo; apertura anguste lunata, perobliqua.

Lat. $1\frac{1}{2}$ lin., alt. $1\frac{1}{4}$ lin.

Hab. Tago.

This is a well-marked species, of very peculiar form, very

similar to the former, but larger and with fewer whorls. I found but a single example, at Tago, on the shores of the inland sea.

Subfam. *CLAUSILIINÆ*.

Genus *BALEA*, Prid.

Balea variegata, A. Ad.

B. testa sinistrali, rimata, fusiformi, tenui, oblique striata, corneo-fusca, albo variegata; anfract. 6, convexiusculis, lineolis transversis impressis ornatis; apertura pyriformi, obliqua; peristomate albilabiato, interrupto, marginibus expansis.

Long. $4\frac{1}{2}$ lin., diam. (anfract. ultimi) $1\frac{1}{4}$ lin.

Hab. Tago.

This is a very interesting addition to a genus so limited in species as *Balea*. It is a prettily variegated shell, and is found in localities similar to those preferred by *Clausilia*.

Genus *CLAUSILIA*, Draparn.

1. *Clausilia (Phædusa) Martensi*, Herklots, Zeitschr. 1859.

Hab. Tabu-Sima.

2. *Clausilia (Phædusa) Buschii*, Kust.

Hab. Japan (Kuster).

I did not meet with this species.

3. *Clausilia (Phædusa) Sieboldi*, Pfr.

Hab. Tsus-Sima.

4. *Clausilia (Phædusa) pluvialis*, Bens.

Hab. Awa-Sima.

Found also by Mr. Benson in Chusan.

5. *Clausilia (Phædusa) aculus*, Bens.

Hab. Tsaulian, Odsi.

6. *Clausilia (Phædusa) valida*, Pfr.

Hab. Awa-Sima.

Found also in the Liewkiew Islands.

7. *Clausilia (Phædusa) plicilabris*, A. Ad.

C. testa rimata, fusiformi, solida, oblique striata, luteo-fusca; spira sursum attenuata, apice obtusa; anfract. 10, planis, ultimo antice tumido, rotundato; apertura pyriformi, obliqua, lamella supera valida, compressa, infera profunda bipartita; lunella inconspicua; plica palatali 1, suturæ parallela, longa, arcuata, subcolumellari

usque ad marginem peristomatis producta; perist. continuo, breviter soluto, crasso, margine dextro plicis pluribus corrugato.
Long. 8 lin., diam. (anfract. penult.) 2 lin.

Hab. Tanabe.

The most striking peculiarity in this species is the wrinkled or plicate nature of the right margin of the peristome.

8. *Clausilia* (*Phædusa*) *Stimpsoni*, A. Ad.

C. testa vix rimata, fusiformi, solida, pallide fusca, oblique striata; anfract. 9, planatis, ultimo antice angustato, rotundato; apertura parva, pyriformi, lamella supera valida compressa, infera profunda, callosa; lunella inconspicua; plica palatali longa, arcuata, suturæ parallela, subcolumellari usque ad marginem peristomatis producta; peristomate albilabiato, undique expanso, margine subincrassato.

Long. $6\frac{3}{4}$ lin., diam. (anfract. penult.) $1\frac{1}{4}$ lin.

Hab. Tsus-Sima, Awa-Sima.

A pale-brown, rather coarsely striated species, with the peristome white and thickened, and with the subcolumellar plica ending conspicuously on the right margin.

9. *Clausilia* (*Phædusa*) *stenospira*, A. Ad.

C. testa rimata, fusiformi, solida, oblique strigillata, viridi-fusca; spira sursum valde attenuata; anfract. 11, planiusculis, ultimo antice in cristam basalem compresso; apertura pyriformi; lamella supera compressa, infera valida callosa; lunella imperfecta; plica palatali 1 longa, suturæ parallela, subcolumellari intra marginem peristomatis desinente; perist. continuo, undique expanso, subreflexo, margine sinistrâ inflexo, subincrassato.

Long. $8\frac{1}{2}$ lin., diam. (anfract. penult.) 2 lin.

Hab. Kino-O-Sima.

A greenish-brown species, with the peristome expanded but not reflexed, and with the left margin bent inwards and thickened.

10. *Clausilia* (*Phædusa*) *Gouldi*, A. Ad.

C. testa vix rimata, fusiformi, solida, pallide fusca, oblique striata; spira sursum valde attenuata, apice acutiuscula; anfract. 9, planiusculis, ultimo antice rotundato; apertura obliqua, pyriformi; lamella supera compressa, infera valida, arcuata, producta; lunella imperfecta; plica palatali 1 longa, suturæ parallela, subcolumellari usque ad marginem peristomatis producta; perist. albo, subincrassato, undique breviter expanso.

Long. 8 lin., diam. (anfract. penult.) $1\frac{1}{4}$ lin.

Hab. Tago.

A neat, dirty-brown, strongly striated species, with the spire very much attenuated towards the apex.

11. *Clausilia* (*Phædusa*) *proba*, A. Ad.

C. testa arcuato-rimata, fusiformi, solida, oblique striata, corneofusca; spira subattenuata, apice obtuso; anfract. 8, planiusculis, ultimo antice rotundato; apertura pyriformi; lamella supera valida, compressa, infera profunda, substricta; lunella inconspicua, imperfecta; plica palatali longa, parum curvata, suturæ parallela, subcolumellari profunda; perist. breviter soluto, crasso, undique expanso.

Long. $5\frac{1}{2}$ lin., diam. (anfract. penult.) $1\frac{1}{2}$ lin.

Hab. Kino-O-Sima.

A neat, simple, horn-coloured species, with several small palatal plicæ seen through the shell, forming an imperfect lunule.

12. *Clausilia* (*Phædusa*) *spreti*, A. Ad.

C. testa vix rimata, fusiformi, luteo-fusca, obsolete oblique striata; anfract. 8, convexiusculis, ultimo antice rotundato; apertura parva, pyriformi, obliqua; lamella supera valida, infera profunda, sursum bipartita; lunella imperfecta; plica palatali suturæ parallela, subcolumellari inconspicua; peristomate continuo breviter soluto, luteo-labiato, undique expanso.

Long. 5 lin., diam. (anfract. penult.) $1\frac{1}{2}$ lin.

Hab. Tago.

A small, smooth, yellowish-brown species, with the surface generally very much eroded, and with the spire usually decollated.

13. *Clausilia* (*Phædusa*) *pinguis*, A. Ad.

C. testa arcuato-rimata, pupoidea, oblique striata, lutescente, solida; spira attenuata; anfract. 8, convexiusculis, ultimo basi in cristam brevem compresso; apertura obliqua, pyriformi; lamellæ validæ, supera compressa, infera ascendente incrassata; lunella imperfecta; plica palatali longa, suturæ parallela, subcolumellari usque in marginem peristomatis producta; perist. crasso, continuo, undique expanso.

Long. $6\frac{1}{2}$ lin., diam. (anfract. penult.) 2 lin.

Hab. Kino-O-Sima.

A short, fat, pupiform species, with the peristome thickened and expanded, but not widely reflexed.

14. *Clausilia* (*Phædusa*) *lirulata*, A. Ad.

C. testa arcuato-rimata, fusiformi, tenui, læte fuscescente oblique striata; spira elongata, sursum attenuata; anfract. 10, planiusculis, lirulis transversis impressis ornatis, ultimo antice subconstricto rotundato; apertura parva, pyriformi; lamina supera compressa sursum bipartita, infera profunda, ascendente; lunella imperfecta; plica palatali 1 longa vix curvata, subcolumellari

usque in marginem peristomatis producta; perist. pallido, margine subincrassato, undique expanso.

Long. $6\frac{1}{2}$ lin., diam. (anfract. penult.) $1\frac{1}{4}$ lin.

Hab. Mososeki.

A very pretty slender species, with several transverse impressed lines on the whorls.

LV.—Observations on some proposed new Species of *Oliva*.

By F. P. MARRAT.

IN the May Number of the 'Annals,' p. 344, Mr. Ponton, of Clifton, has taken exception to the whole of my proposed new species of the genus *Oliva*. It is, I think, a grave offence to occupy the pages of the 'Annals' with conclusions hastily adopted; and I therefore beg permission to clear myself of the implied charge of having done so.

The collection from which the materials of my paper were taken has been the work of several years: it contains of each of the more variable species from forty to one hundred or more specimens, and includes, with the exception of a very few (perhaps five or six), every species and every named variety that I have been able to find figured or described in the works of Lamarck, Sowerby, Chenu, Gray, and Reeve. In such a series, numbering some thousands of specimens, it might reasonably be expected that undescribed forms would occur as much deserving to be named as many of the forms identified by the above-named authorities. My supposed new forms have been selected with much care and reserve; and all pretensions to be able to make positive assertions on the extent or limit of particular species I freely resign to others.

Mr. Ponton states that colour altogether fails as a specific character in this genus. It is not surprising that an inspection of such species as *O. ispidula*, Linn., *O. irisans*, Lam., *O. maura*, Lam., and *O. ventricosa*, Soland., should produce an impression of this kind; but nowhere amongst the Gastropoda are the indications afforded by colour of more value than in the genus *Oliva*. Even slight differences of shade may often afford a clue leading to the recognition of affinities afterwards abundantly substantiated by more permanent characters.

I find in Reeve's monograph, after the description of *O. volvarioides*, the following remark:—"The uniform chestnut colouring appears to be peculiar to the species in this instance." At the same time Mr. Reeve forgets to tell us that Duclos has figured a nearly white variety on the same plate; and also that there is a variety of *O. lepida*, Duclos, of a uniform chestnut-

colour. Again, in his description of *O. pulchella*, Reeve (not Duclos, as quoted) tells us that it differs from *O. lanceolata*, Reeve, in having the spots invariably removed from the sutures.

Mr. Ponton says that the purple stain at the base of the columella is a marked character of *O. reticularis*, Lam. I will enumerate the species or varieties with and without this stain.

1. Having no stain:—*O. reticularis*, Lam. (Reeve, pl. 10. fig. 16a), stated in Reeve's description to be the type. There are forty specimens of this variety before me, and I have examined at least two hundred more without finding in any one of them the slightest trace of the stain mentioned by Reeve and quoted by Mr. Ponton; neither does it occur in any specimens of the smaller West-Indian variety examined by me. *O. timorea*, Duclos, *O. obesina*, Lam., *O. Melchersi*, Mke. (*O. araneosa*, Lam.) (four pale varieties), *O. pindarina*, Duclos (six pale varieties), *O. ustulata*, Lam., *O. hepatica*, Lam., *O. julieta*, Duclos, *O. polpastu*, Duclos, *O. peruviana*, Lam. (normal form), and *O. fusiformis*, Lam.

2. More or less stained:—*O. incrassata*, Soland. (*O. angulata*, Lam.), five out of fourteen specimens; *O. subangulata*, Philippi, *O. Melchersi*, Mke. (*O. araneosa*, Lam.), all the dark varieties; *O. pindarina*, Duclos, all the dark varieties; Reeve's shell, figured at pl. 10. fig. 16h, of which there are two very much finer specimens than the one figured lying on my table (they were sent by a resident in Jamaica, and gathered by himself on the shore of that island; but I must remark that the resemblance, spoken of by Reeve, to the variety *O. araneosa*, Lam., does not appear to me so striking). The shell figured at pl. 11. fig. 16h has the columellar lip of a uniform dark-brown colour. *O. splendidula*, Sow.; *O. Cumingii*, Reeve. I have not observed an approach to the colour of this shell in any specimen in the *reticularis* group; whereas shells of a similar colour and character with the stain at the base are of frequent occurrence among the abnormal forms of *O. peruviana*, Lam. (of which the *O. ligneola*, Reeve is one), the *O. intertincta*, Carpenter, *O. inflata*, Lam., *O. nebulosa*, Lam., and *O. undatella*, Lam. In fact *O. reticularis*, as at present constituted, is (like the term *Fucus* in geology, anything in the form of a plant) anything in the form of an Olive. Having the whole of the species and varieties described both by Reeve and Duclos, and at least twelve others in that group of which I have seen either a figure or description, neither my *O. violacea* nor *jamaicensis* will agree with any of them.

Now, with regard to *O. truncata*, Marrat; since describing this species, several other specimens have been examined by
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me, all agreeing in form and marking with my shells; so that I am more convinced that this is a good form.

O. polita, Marrat, is made a variety of *O. jaspidea* of somebody not quoted. My shell has no affinity with the *O. jaspidea*, Gmelin, but somewhat resembles the *O. jaspidea*, Duclos, which is the same as *O. Duclosii*, Reeve.

O. piperata, Marrat. Here Mr. Ponton remarks that *O. conoidalis*, Lam., is simply a variety of *O. jaspidea*, not mentioning whether it be the *O. jaspidea*, Duclos, or *O. jaspidea*, Gmelin. If the former, there is no relation; if the latter, the names are synonymous.

O. faba, Marrat, is placed as a variety of *O. carneola*, Lam. (*O. aurora*, Soland.). According to a recent monograph by Dr. Gray, my shell belongs to the genus *Strephona*, having the spire open to the tip, and *O. carneola*, Lam., to the genus *Galeola*, embracing shells with a callous spire. I may remark that after three years' search for any open-spined shell in this group—viz. *O. calosoma*, Duclos (a beautiful species), *O. tigrina*, Meusch. (*O. tessellata*, Lam.), *O. todosina*, Duclos, *O. lepida*, Duclos, *O. volvarioides*, Duclos, *O. athenia*, Duclos (not figured by Reeve, but quoted as a variety of *O. carneola*, Lam.), and *O. picta*, Reeve—I have failed in my attempt. In a drawer on my table one hundred specimens are arranged, consisting of all the figured varieties in the series, and several others neither figured nor described.

O. blanda, Marrat. Mr. Ponton considers this to be a form of *O. ispidula* of somebody. If he mean the shell of Linu., I must inform him that the white shell of which he speaks is the *O. candida*, Lam. (*O. olerinella*, Duclos), and was separated by both these able conchologists, in consequence of the broad plaited columella.

O. oblonga, Marrat. Will Mr. Ponton kindly refer to the figures mentioned in my description?

O. cylindrica, Marrat. Again a species with an open spire and rounded spiral whorls has been referred to the figure of a shell with a callous spire, but in this case with good reason. My description certainly favours the idea; but let me refer to the group in my cabinet. I find seventy-three specimens under the head of *O. irisans*, Lam., including all the varieties figured in any work to which I have access, and many more beautiful than their more favoured paper brethren; but the eighteen shells under the head of *O. cylindrica*, Marrat, will not agree with any of them.

O. ornata, Marrat, has been imported in considerable numbers, and is an acknowledged species by every conchologist who has seen it.

O. pallida, Marrat, will not agree with any figure or description of *O. scripta*, Lam. There is a very considerable difference between the *O. scripta*, Lam., as figured by Reeve, and the *O. scripta*, Lam., as figured by Duclos; and a much greater difference exists between the shells in my cabinet and the forms figured.

O. similis, Marrat, is so decidedly distinct as to require no comment.

2 Peveril Terrace, Edge Lane, Liverpool.
May 16, 1868.

LVI.—*Diagnoses of some new Freshwater Fishes from Surinam and Brazil, in the Collection of the British Museum.*
By Dr. ALBERT GÜNTHER.

THE Trustees of the British Museum obtained, in the course of last year, several collections of South-American Fishes, of which we may mention that made by Mr. Edward Bartlett on the Huallaga and at Xeberos (Upper Amazons), others sent by Hr. Kappler from the Maroni River (Surinam), and, finally, numerous examples from Surinam, formerly in the museum of the late Dr. van Lidth de Jeude. For the present I give the diagnoses of those species which I have found to be undescribed; and more detailed descriptions with illustrations will be published in the 'Proceedings of the Zoological Society,' before which the paper was read on March 26.

Doras helicophilus.

Lateral shields well developed, entirely uncovered by the skin; the depth of the third is one-half of the length of the head, those on the tail only half as deep as the tail; their whole surface is covered with minute spines. Humeral process without spines, with a very slight ridge extending to the hinder third of the pectoral spine. The posterior lobes of the nuchal carapace are rounded, reaching to the base of the second soft ray of the dorsal fin. Dorsal spine serrated in front and behind, the anterior denticulations being directed upwards. Caudal peduncle shielded above and below. Uniform blackish; dorsal fin white, the middle black.

Surinam.

Oxydoras acipenserinus.

This fish is distinguished from all its congeners by the peculiar shape of the head and snout, which is elongate triangular, pointed, and much depressed in its anterior portion. L. lat. 42.
Xeberos.

Callichthys armatus.

This species belongs to the group with compressed head.

Dorsal spine as high as the body, finely serrated behind; pectoral spine rather stronger but shorter than that of the dorsal, longer than the head. Anal spine shorter and more feeble than that of the adipose fin. Olive-coloured (in spirits), the nine or ten anterior scutes with vertical series of small blackish spots.

Xeberos and Huallaga.

Chaetostomus Fordii.

Head much depressed, elongate, its length being one-third of the total (without caudal). Eye small, one-eighth of the length of the head, and two-fifths of the width of the interorbital space, which is rather flat. Each jaw with six or seven stoutish teeth on each side; each of them has a lobe on its outer side, rather distant from the brown flat apex. Throat, thorax, and belly naked. The first ray of the dorsal and anal, and the upper and lower of the caudal, slightly thickened and rough. Pectoral spine strong, extending to the second third of the ventral fin, covered with short hooks. Each scute of the body with a series of three or four very prominent spines. Ten scutes between anal and caudal, and eight between the two dorsal fins. Brownish black; most of the scutes have a round bluish-white dot at the base; lower parts with numerous similar but more distinct white dots.

Surinam.

Chaetostomus depressus.

Head and trunk much depressed and flattened. The length of the head is rather more than one-third of the total (without caudal); the diameter of the eye is one-fifth of the length of the head, and *two-thirds of the width of the interorbital space*. The margin of the snout is covered with short bristles; interoperculum with a bundle of about eight similar bristles, the longest being only half as long as the eye. The lower side of the head, thorax, and belly entirely naked. Pectoral spine extending to the second third of the ventral, and rather rough; eleven scutes between the anal and caudal fins. Scutes with numerous striae, each stria composed of numerous very small spines. Brown; each scute with several round, very small, whitish dots; dorsal and caudal rays with a series of similar dots, the interradial membrane being immaculate.

Surinam.

Chaetostomus megacephalus.

Head but slightly depressed, rather longer than broad, its

length being more than one-third of the total (without caudal). The horizontal diameter of the orbit is more than one-half of the width of the interorbital space, and about one-fifth of the length of the head. Margin of the snout granulated, without bristles; interoperculum with a bundle of about twenty setiform spines, the longest of which are about one-fourth of the length of the head, and extend backwards to the root of the pectoral fin. Thorax and belly entirely naked. Twelve scutes between the anal and caudal fins. Scutes of the body without keels, but with vertical series of spines, the anterior scutes with one series only, the middle with two, and the posterior with three or more. Blackish brown; head and body with numerous indistinct round yellowish spots, each about as large as the pupil; each dorsal ray with a series of round whitish spots, the black ground-colour forming a network on the fin.

Surinam.

Chaetostomus dentex.

Interoperculum with a bundle of about ten straight setiform spines, the longest of which is as long as the eye. Thorax and belly nearly entirely naked, there being only a few granulations behind the throat. Teeth comparatively large, with the apex dilated, scarcely lobed; there are about six on each side in the upper jaw, and three in the lower. Scutes not keeled, but covered with strong spines. Uniform greyish brown.

Xeberos.

HYPOPTOPOMA (g. n. *Hypostomatin.*).

This genus differs from *Plecostomus* in the peculiar formation of the head, which is depressed, spatulate, the eyes being on the lateral edge of the head. The moveable gill-covers are reduced to two bones, viz.:—the operculum, small and placed as in *Plecostomus*; and a second, larger bone (interoperculum?), separated from the eye by the narrow suborbital ring, and placed at the lower side of the head.

Hypoptopoma thoracatum.

D. $\frac{1}{8}$ | 1. A. 6. P. $\frac{1}{6}$. V. $\frac{1}{5}$. L. lat. 24.

Xeberos.

Loricaria lanceolata.

Head and body much depressed, but narrow, the greatest width of the head being three-fifths of its length. Lower lip broad, slightly notched behind, fringed. Teeth very fine, few in number, about five on each side in the upper jaw, and about seven in the lower. Orbit with a rather shallow notch behind, its horizontal diameter (the notch included) being two-thirds

of the width of the interorbital space, which is flat. Thorax and abdomen covered with irregular scutes. The length of the head (measured to the occiput) is a little more than one-fifth of the total (without caudal). Origin of the dorsal fin opposite to the root of the ventral. Brown; back with about five obscure dark cross bands; fins with broad, irregular, confluent, black cross bands.

Xeberos.

Loricaria platystoma.

Snout of moderate length, slightly pointed; mouth broad, upper lip well developed, lower semicircular, of moderate length, papillose, not fringed, and with a minute barbel near the angle of the mouth. Teeth very fine, about forty on each side of each jaw, the series occupying nearly the whole width of the mouth. Orbit nearly circular, without notch, its horizontal diameter being two-thirds of the width of the interorbital space, which is slightly concave. Scutes remarkably smooth, even the lateral ridges of the body and tail being obtuse. There is a series of seven or eight scutes between the roots of the pectoral and ventral fins. Thorax and abdomen covered with small irregular scutes. The length of the head (measured to the occiput) is contained five times and one-third in the total (without caudal). Origin of the dorsal nearly opposite to that of the ventral. Uniform brownish (in spirits).

Surinam.

Loricaria lamina.

Head and body excessively depressed; snout of moderate length, very broad, the head being nearly as broad as long. Labial folds thin, fringed. Teeth minute, few in number; there are about five on each side in the upper jaw, and seven in the lower. Orbit small, with a shallow notch behind; its horizontal diameter (the notch included) is three-fourths of the width of the interorbital space, which is nearly flat. Edge of the snout trenchant. There is a series of nine scutes between the roots of the pectoral and ventral fins. Thorax and abdomen covered with small, irregular scutes. The length of the head (measured to the occiput) is contained four times and one-third in the total (without caudal).

Xeberos.

Curimatus asper.

D. 11. A. 12-13. V. 9-10. L. lat. 51. L. transv. $\frac{12-14}{9}$.

The height of the body is contained twice and two-thirds or thrice in the total length (without caudal), the length of the head thrice and one-half. Snout as long as the diameter of the eye, which is a little more than one-half of the width of

the interorbital space. Snout somewhat projecting beyond the mouth. The second suborbital bone is twice and one-half as long as deep. Abdomen flat before the ventrals, compressed behind them. Scales with their entire margin conspicuously serrated. Coloration uniform.

Huallaga and Xeberos.

Curimatus leuciscus.

D. 11. A. 9. V. 10. L. lat. 64. L. transv. $\frac{11}{10}$.

The height of the body is contained thrice and two-thirds in the total length (without caudal), the length of the head four times. Upper profile of the head and nape straight. Snout a little longer than the eye, which is three-fifths of the width of the interorbital space. Snout somewhat projecting beyond the mouth; the second suborbital bone is more than twice as long as deep. Origin of the dorsal fin equidistant between the end of the snout and the adipose fin, considerably in advance of the ventrals. Pectoral terminating at a considerable distance from the ventral, ventral terminating close to the vent. Abdomen rounded before and behind the ventrals. Scales with their entire margin conspicuously serrated. Coloration uniform.

Huallaga.

Curimatus dobula.

Allied to *C. Troschelii*.

D. 12. A. 10. L. lat. 43. L. transv. $\frac{6}{7}$.

The height of the body is contained thrice and four-fifths in the total length (without caudal), the length of the head four times. Upper profile slightly convex on the nape. Abdomen rounded in front and behind the ventrals. Snout rather shorter than the eye, the diameter of which is contained thrice and one-third in the length of the head, and is less than the width of the interorbital space. The origin of the dorsal fin is nearly midway between the end of the snout and the adipose fin, corresponding to the tenth scale of the lateral line. The pectoral fin terminates at some distance from the ventral. Scales with a few obtuse denticulations. Body silvery; dorsal fin with an indistinct, oblique, blackish band ascending forwards.

Huallaga.

Hemiodus Kappleri.

Closely allied to *H. notatus*, but with the body much more elongate.

Surinam.

Leporinus hypselonotus.

D. 10. A. 13. V. 9. L. lat. 37-38. L. transv. 6/7.

The height of the body is contained twice and one-half or twice and two-thirds in the total length (without caudal), the length of the head four times and one-half or four times and two-thirds. Back much elevated, with its profile very convex to the dorsal fin. Body with seven more or less broad, oblique, blackish cross bands—the two anterior in front of the dorsal, the third from the anterior dorsal rays to behind the ventral fins, the fourth corresponding to the vent, the fifth to the middle of the anal, the sixth from the adipose fin, and the seventh round the last caudal scales. Anterior part of the base of the dorsal and the ventrals deep black, the other fins yellowish.

Xeberos.

Tetragonopterus ovalis.

D. 11. A. 26. L. lat. 31. L. transv. 5½/6.

The height of the body is one-half of the total length (without caudal); the length of the head is contained thrice and two-thirds in it. Upper profile rather more convex than lower, slightly concave on the nape. The diameter of the eye is more than the width of the interorbital space, less than the length of the snout, and one-third of that of the head. The maxillary extends somewhat beyond the vertical from the front margin of the orbit. Origin of the dorsal fin immediately behind the root of the ventral. Pectorals extend beyond the ventrals, ventrals to the vent. There are four longitudinal series of scales between the lateral line and ventral

Xeberos.

APHYCHARAX, g. n.

This genus belongs to the *Tetragonopterina*, and is, technically, distinguished from *Chirodon* by the presence of maxillary teeth.

Dorsal fin placed in the middle of the length of the body, behind the ventrals; anal rather long. Body oblong, covered with scales of moderate size. Lateral line visible on a part of the scales only. Abdomen rounded before the ventrals. Cleft of the mouth narrow; maxillary short; intermaxillary, maxillary, and mandibles with a single series of pointed teeth, those in the intermaxillary having a minute lobe on one or both sides; all the others appear to be simply pointed.

Aphycharax pusillus.

D. 9. A. 18. V. 8. L. lat. 36. L. transv. 12.

Huallaga and Xeberos.

Anacyrtus affinis.

D. 11. A. 55. L. lat. 80.

Upper and lower jaws on each side with a pair of short, conical, tooth-like processes directed forwards and outwards. Intermaxillary teeth in two irregular series,—those of the mandible being in a single series, two pairs of them larger than the rest, canine-like. Maxillary with four or five distant, short, conical teeth. Back much elevated, the profile on the nape being deeply concave. The height of the body is contained twice and two-thirds in the total length (without caudal), the length of the head four times.

Lower jaw considerably shorter than the upper; maxillary not extending to the vertical from the front margin of the eye. Suborbital touching the lower præopercular limb. The diameter of the eye is equal to the width of the interorbital space, or to the length of the snout, and two-sevenths of that of the head. Origin of the dorsal fin opposite to that of the anal, rather nearer to the end of the snout than to the root of the caudal. Pectoral extending beyond the vent.

Huallaga.

Anacyrtus (Cynopotamus) amazonum.

D. 11. A. 40. V. 8-9. L. lat. 110.

The height of the body is contained twice and two-thirds in the total length (without caudal), the length of the head thrice and three-fourths. Upper profile deeply concave on the nape, the back being much elevated. Abdomen not compressed, but with a median ridge from behind the ventrals. The intermaxillary and mandibular teeth are in a single series. The upper jaw overlaps the lower slightly; the maxillary extending far behind the eye, which is rather small, placed in the middle of the depth of the head, nearer to the snout than to the gill-opening. Suborbital slightly and irregularly striated. Origin of the dorsal fin nearer to the end of the snout than to the root of the caudal, its last ray being opposite to the origin of the anal fin. Operculum very narrow; a naked space between the suborbital and lower limb of the opercle.

Xeberos.

Sternopygus axillaris.

Orbit without free eyelid; mouth of moderate width, with the jaws even in front; upper profile of head and nape nearly straight. A large blackish spot on the beginning of the lateral line.

Para.

LVII.—*Notulæ Lichenologicæ*. No. XXII.

By the Rev. W. A. LEIGHTON, B.A., F.L.S.

In the 'Flora,' May 6, 1868, Dr. Wm. Nylander publishes the following additions to our British Lichens:—

1. *Calicium diploëllum*, Nyl.

Thallus vix ullus proprius; apothecia nigra, brevissime stipitata, capitulo turbinato (crassit. 0·05–0·07 millim., in humido statu duplo crassiore), aperto, massa sporali vix prominula; sporæ nigrescentes, oblongæ, simplices, longit. 0·006–0·009 millim., crassit. 0·003, deinde (in massa sporali) 1-septatæ et nonnihil crassiores (crassit. 0·0045 millim.).

In Hibernia, Killarney, ad corticem ilicis (Carroll).

Species omnium minutissima et facillime dignota. Prope *C. disseminatum* locum habet.

2. *Calicium retinens*, Nyl.

Thallus albus, opacus, tenuis, subfarinaceus, effusus (an proprius?); apothecia nigra, minuta (crassit. 0·10–0·25 millim.), sessilia, lecideiformia, massa sporali non distincta; sporæ nigrescentes, oblongæ vel oblongo-cylindricæ, conspicue 1-septatæ, longit. 0·008–0·011 millim., crassit. 0·0025–0·0035 millim.; hypothecium rubricoso-fuscescens.

In insula Cæsarea (Jersey) ad corticem quereus (Larbaletstier).

3. *Lecanora holophæa*, var. *glauco-psora*, Nyl.

Thallus squamuloso-crenatus vel squamulis totis granulatis (vel passim subleprosis); apothecia livido-fusca, mediocria (latit. 1 millim. vel minora), margine thallino subintegro cincta; sporæ 8, incolores, fusiformes, 1-septatæ, longit. 0·012–0·018 millim., crassit. 0·003–0·004 millim.; paraphyses gracilescentes, apice clavato fuscescente. Iodo gelatina hymenea cærulescens.

In insula Cæsarea (Larbaletstier).

Spermatia longit. 0·003 millim., crassit. 0·001 millim., arthrosterigmatibus infixa.

4. *Lecidea arceutina*, var. *hypnæa*, Nyl.

Thallus albidus vel albo-cinereus, tenuissimus; apothecia fusca vel nigricantia, demum convexa (latit. 0·5 millim.); sporæ longit. 0·045–0·070 millim. Iodo gelatina hymenea cærulescens.

Supra muscos in insula Cæsarea (Larbaletstier).

5. *Lecidea ascaridiella*, Nyl.

Thallus albidus, tenuis, opacus, rimulosus, determinatus; apothecia nigricantia, innata, minutissima (latit. 0·09–0·15 millim.), intus incoloria, margine quasi thallode crenatulo sæpe coronata; sporæ 16–32, vermiformes (utroque apice acutæ), semel curvatæ aut bis tortæ, simplices, longit. 0·025–0·030 millim.; paraphyses gracillimæ, non confertæ; epithecium leviter fuscescens; hypothecium incolor. Iodo gelatina hymenea non tincta.

Ad saxa calcarea prope Killarney in Hibernia (Carroll).

Species stirpis *Gyalectarum* minuta, bene distincta, prope *Lecideam leucaspidem* (Kphb.) locum habens.

6. *Verrucaria hibernica*, Nyl.

Vix nisi var. *V. pyrenuloidis* (Mnt.), Nyl. Pyren. p. 44. Facie fere *V. nitidæ*, sed apotheciis aggregatis, sporis multiloculosis (seriebus transversis 12 et pluribus pluriloculosis) 4–8 (longit. 0·070–0·110 millim., crassit. 0·025–0·038 millim.). Iodo gelatina hymenea leviter vel thecæ vinose rubescentes.

Ad corticem *Coryli avellanæ* loci umbrosi in Killarney, Turk Mountain (altit. circiter 800 pedum) legit (Sept. 1867) I. Carroll.

7. *Verrucaria elongatula*, Nyl.

Similis *V. punctiformi* vel *atomariæ*, Ach., sed sporis clavato-fusiformibus, longioribus (longit. 0·023–0·033 millim., crassit. 0·005–0·006 millim.), uniseptatis. Apothecia minutissima (latit. 0·1 millim. vel sæpe minora); perithecium infra (hypothecium) incolor. Paraphyses nullæ evolutæ.

Ad corticem, in Hibernia, Killarney (Carroll).

Forsan modo forma *V. punctiformis*.

8. *Verrucaria punctiformis*, var *deminutula*, Nyl.

Apotheciis minutissimis (latit. circiter 0·07 millim.); sporis oblongis, 1-septatis (longit. 0·016–0·022 millim., crassit. 0·0045 millim.).

In Hibernia, Killarney (Carroll).

9. *Verrucaria leptospora*, Nyl., Flora, 1864, p. 487.

Thallo fusco vel fuscescente, tenui; sporis acicularibus, 7–9-septatis (longit. 0·040–0·060 millim., crassit. 0·003–0·004 millim.).

A *V. olivacea*, Borr., differt jam perithecio integro et sporis longioribus.

MISCELLANEOUS.

Notes on Hyalonema boreale, Lovén.

By Dr. J. E. GRAY, F.R.S. &c.

DR. LOVÉN, in the 'Öfverwigt' of the Swedish Academy for 1868, p. 105, describes and figures in detail a small sponge under the name of *Hyalonema boreale*. I hope shortly to receive a translation of this paper from the author, for insertion in the 'Annals;' and I have no doubt it will contain many interesting observations.

Believing that facts were accumulating that would prove the *Hyalonema* to be a coral, as I first described it, I was rather dismayed when I heard from my friend that he was describing a northern species of the genus that would prove it to be a sponge. On seeing the paper, my difficulty was to understand why so accurate and philosophical a zoologist as Dr. Lovén could have referred it to my genus *Hyalonema*.

Hyalonema boreale, Lovén, is a typical siliceous sponge belonging to my family Halichondriadae, of a pear-shape, with a single sub-central terminal oscule, with a long cylindrical pedicel, and fibrous roots. In general form and structure and in form of spicules it agrees so well with *Halichondria fucus* of Johnston, which is the type of my genus *Ficulina* (see Proc. Zool. Soc. 1867, p. 523), that I am inclined to refer it to that genus. But perhaps it may be necessary to form it into a separate genus, characterized by the length and structure of the pedicel and the absence of the pin-shaped spicule; but at present I should call it *Ficulina borealis*. I cannot find that it presents a single character of the genus *Hyalonema*. In that genus the elongated spicules that form the coil, which induced me to call the genus *Hyalonema* (that is, glass rope), arise out of the centre of a sponge with a flat expanded base, by which it is attached to some marine bodies; and the sponge is furnished with numerous superficial oscules. In *H. boreale*, on the contrary, the sponge is clavate, with a pear-shaped body on a long slender cylindrical pedicel having a fibrous root. This pedicel is a true part of the sponge, and cannot in any way be compared with the coil of siliceous fibres that arises out of the upper part of the sponge in *Hyalonema*.

Dr. Lovén observes:—"You will see that, if I am not very wrong, all who have treated of the *Hyalonema* have inverted it, turned it upside down, and that the twisted rope, instead of rising out of the sponge, in reality is nothing but the remaining part of the stalk."

I fear Dr. Lovén has only had very imperfect specimens of the Japan *Hyalonema* to examine, or he could not have adopted such a theory.

Dr. Wyville Thompson has informed me that he dredged a specimen of Dr. Lovén's *Hyalonema boreale* a couple of years ago, in Oban Bay.

Note on the Shell-structure of certain Naiades.

By C. A. WHITE, M.D.

Those who have given attention to fossil Lamellibranchiates cannot fail to have observed that, whenever the shell-substance is preserved at all, it is universally thin, even in large specimens—too thin, indeed, to have given sufficient protection to the mollusk which it enclosed. It seems evident, therefore, that some portion of the shell-substance must have disappeared during the process of fossilization. Thus those fossil shells which possess a prismatic outer layer usually have this layer alone preserved, at least when they occur in calcareous strata. Numerous specimens of *Myalina subquadrata* from the Upper Coal-measures, and *Inoceramus problematicus* of the Cretaceous of Western Iowa, illustrate this well, in which the interior markings are uniformly obliterated. While lately examining the Naiades of the Iowa river I observed that they all possessed a prismatic outer layer of a character not distinguishable from that of *Myalina subquadrata*. The prisms are of about the same size in each; but those of the *Inoceramus* are nearly twice as large.

The following species have thus far been found to possess the characters referred to:—*Unio alatus*, Say, *U. cornutus*, Barnes, *U. crassus*, Say, *U. ebenus*, Lea, *U. plicatus*, Say, *U. rectus*, Lam., *U. securis*, Lea, *U. tuberculatus*, *U. ventricosus*, Barnes, *Alasmodonta complanata*, Barnes, *A. truncata*, Say, and an undetermined species of *Anodonta*.

This comprises all the genera (or subgenera) found in our region; but it is not improbable that the prismatic structure is common to the whole family. The prismatic layer is of about the same thickness in all, the *Anodontas* and *Alasmodontas* being thinned at the expense of the inner or structureless layers; it is from half a millimetre to more than a millimetre in thickness, the epidermis resting directly upon it. Except in very old specimens, this layer constitutes the whole thickness of the shell for the width of a couple of millimetres from the margin; and in very young specimens it exclusively occupies about half the space between the margin and the pallial line.

The prismatic structure may be detected by the naked eye, and can be well studied by the use of one of Tolles's $\frac{1}{4}$ -inch triplet lenses. Under this magnifier the inner surface of the marginal border is seen to be finely granular, each granule being the convex end of one of the prisms which constitute the layer. These prisms extend through the layer to the epidermis without interruption, reminding one, in their appearance upon fracture, of certain species of *Charaxes*. But viewing the prisms upon their ends they are seen to vary in size much more than the cells of *Charaxes* do, and consequently to lack that uniformity in cross section presented by the coral.

If our Naiades were fossilized under the same circumstances that

the Coal-measure and Cretaceous shells before mentioned have been, even the most massive *Unio*s would doubtless be found with as thin a shell as *Myalina* and *Inoceramus* now possess.

Mr. F. B. Meek's investigations have shown that the prismatic structure is a very common (if not a constant) character of the fossil *Aviculidæ*; and it is doubtless of much value as a family character; but since it is also seen in certain genera of *Mytilidæ* and the *Naiades*, it is known that it is not the peculiar property of any family.—*Silliman's American Journal*, May 1866.

Smelts breeding in an Aquarium.

Mr. Brightwell, passing through the Norwich fish-market the other day, had his attention called by a man to his aquarium, in which he found some smelts, caught in the river, were kept alive. They had deposited spawn on the stones at the bottom; and the young fry had emerged, so exceedingly minute as scarcely to be seen, but distinguishable as young smelts. They make excellent microscopical objects.—L. B.

On the Formation of Coral Reefs. By CARL SEMPER.

The well-known annular form of the reefs containing lagoons, the *atolls*, was formerly explained by supposing that the polypes had built their dwellings, perpendicularly upwards, upon the margins of the craters of submarine volcanoes, by which an external ring (an outer reef) must necessarily be produced, closing the crater, now become a lake, against the outer sea. In this, however, the allied forms of the *barrier reefs* (that is to say, such as fringe elevated islands lying in the sea) and the *coast reefs* occurring in all tropical seas were not taken into consideration. Darwin, by his theory, brought the three forms into mutual connexion. He thought he could demonstrate that the *atolls* and *barrier reefs* could only be explained by the assumption of the gradual *sinking* of a continent or island, and the *coast reefs* by an *elevation* of the shores. Although he himself called attention to some difficulties, he believed he could support the value of his theory in opposition to such obstinate facts, especially by demonstrating how in general the *coast reefs* were formed only on shores now in course of elevation, the *atolls* and *barrier reefs*, on the contrary, in regions of the sea in which the want of all active volcanic energy indicates a depression.

Nevertheless cases do occur which cannot be explained thus. Leaving out of consideration the Philippines, where several *atolls* are found in the midst of islands in course of elevation, the western Caroline Islands, the Pelew Islands, furnish a very striking example of an association of extreme forms. At the north of the chain of islands (which stretches nearly north and south, and is about sixty geographical miles in length), there are true *atolls*; in the middle,

barrier reefs surrounding volcanic islands, and passing gradually towards the south into coast reefs, which are closely applied to coral reefs elevated to as much as 200 feet. The group of islands terminates in a small island entirely destitute of reefs, separated from the rest by a channel four geographical miles in breadth. If we were to apply Darwin's theory to this example, we should have to regard this southernmost island as a resting point, whilst the northern part, by sinking, had rendered the formation of atolls possible. Independent of the improbability that a mountain-chain ascending from the deep sea at a distance from all other insular groups, and having so small a horizontal extension (sixty miles in length by six to seven miles in breadth), should possess so great a difference of vertical movement, facts directly observed testify against a depression, nay, even render it probable that an elevation has taken place in recent times. The northern volcanic islands are formed by two different basaltic eruptions, one of which bears the present and the older elevated reefs of the south, whilst the second partially overlies them. Traces of a trachytic eruption also occur, but, apparently, isolated from the larger basaltic island. These islands, therefore, belong to a comparatively very recent geological period. And the elevated coral reefs of the south, partly converted into dense coralline limestone, in other places decomposed into chalk, pass directly over into the existing reefs. A depression is further disproved by the nature of the submarine surface in the interior of the lagoon-channel. Whilst in the north there is a deep and often very broad channel which separates the outer reef from the shore of the island, the numerous small elevated coralline limestone islands of the south are united by a surface extending for many miles nearly horizontally scarcely 4-6 fathoms beneath the surface of the sea, and which, in still water at the time of the spring tides, may be traced out of the sea into the supramarine rocks and islands. A horizontal surface attaining such colossal dimensions could not possibly be formed during a depression which, a few miles further north, had produced a channel of 70 fathoms in depth.

The author rather regards the physical influences, especially the internal sea-currents caused by the rain, and the exterior direct and diverted ones, as the causes which have produced in the north the atolls, and in the south the coast reefs, simultaneously with an elevation. Whilst in the latter the deep-going eroding action of the wave-blow or the wash of the sea has gradually planed away the dense and solid coralline limestone to a nearly horizontal surface, which lies at about the depth to which the sea-wash is capable of acting, in the north the becks coming down from the mountains, conjointly with the wash and currents of the sea, have acted much more strongly upon the uncommonly soft, readily decomposable basalt of the west, than was the case with the limestone in the south, and have eaten out the deep lagoon-channels, which in particular places extend to the width of a mile between the solid ground and the outer reef.—*Verhandl. der phys.-med. Gesellsch. in Würzburg*, February 1, 1868.

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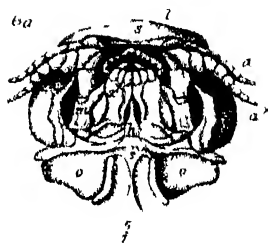
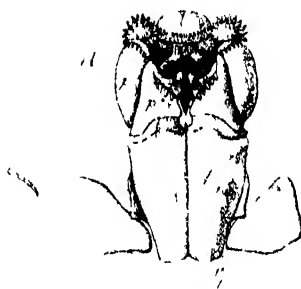
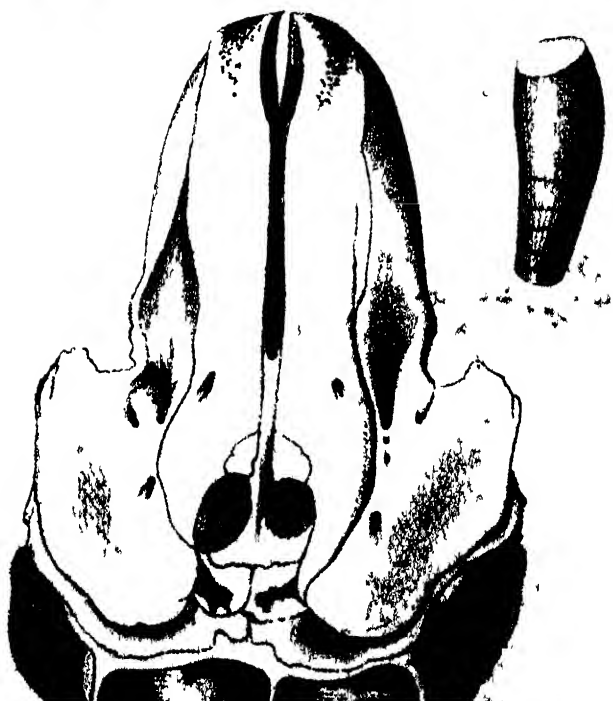
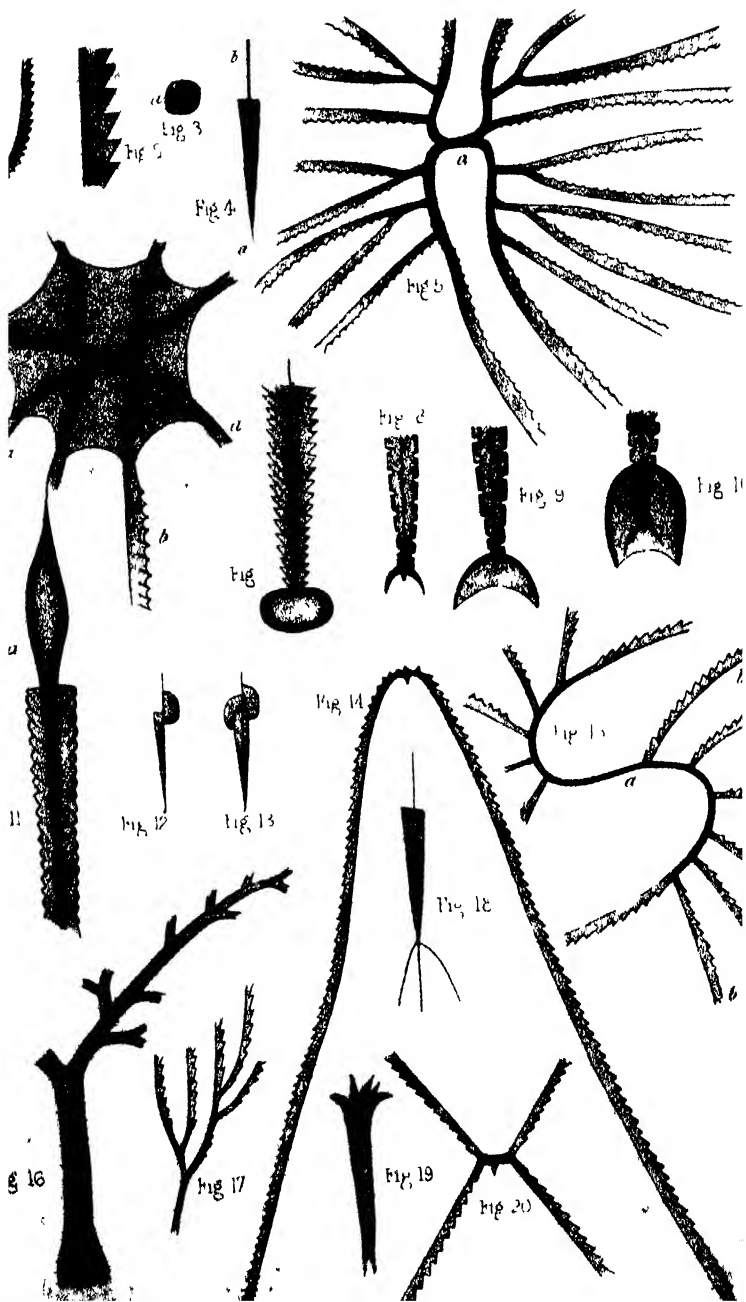
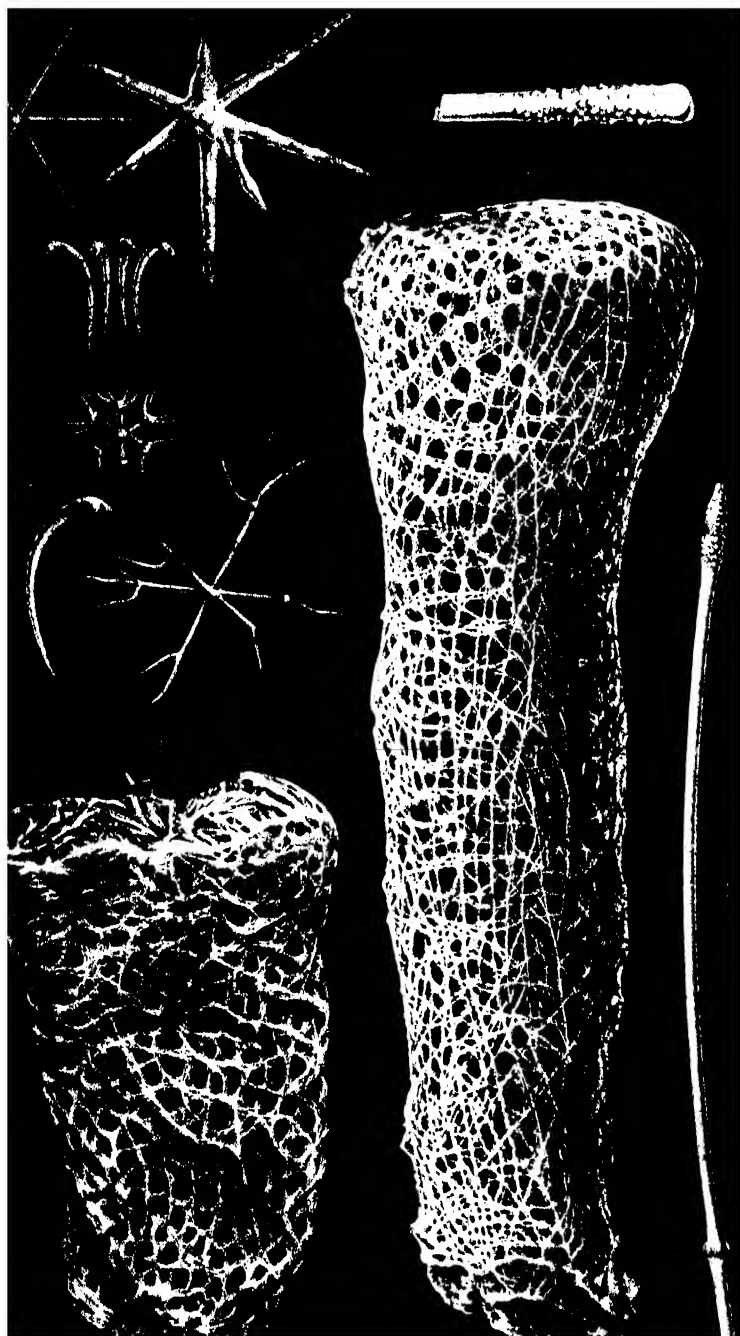


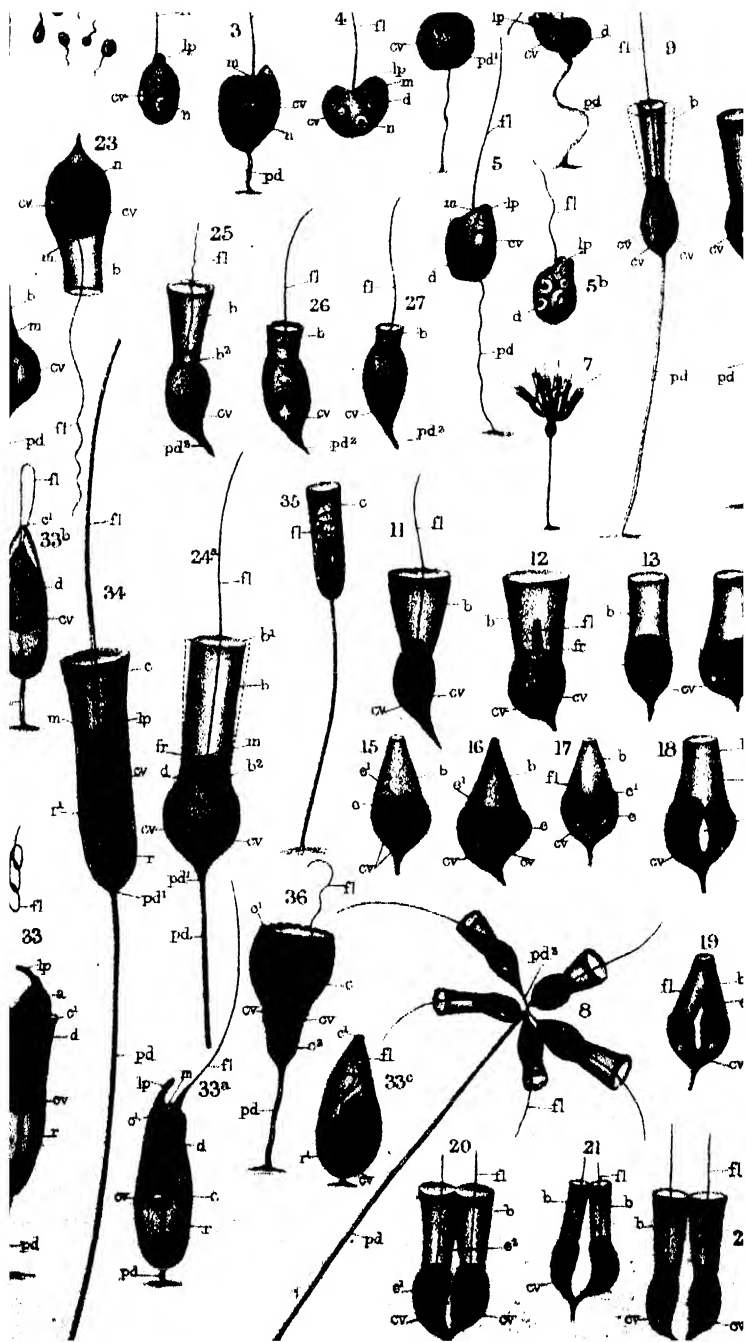


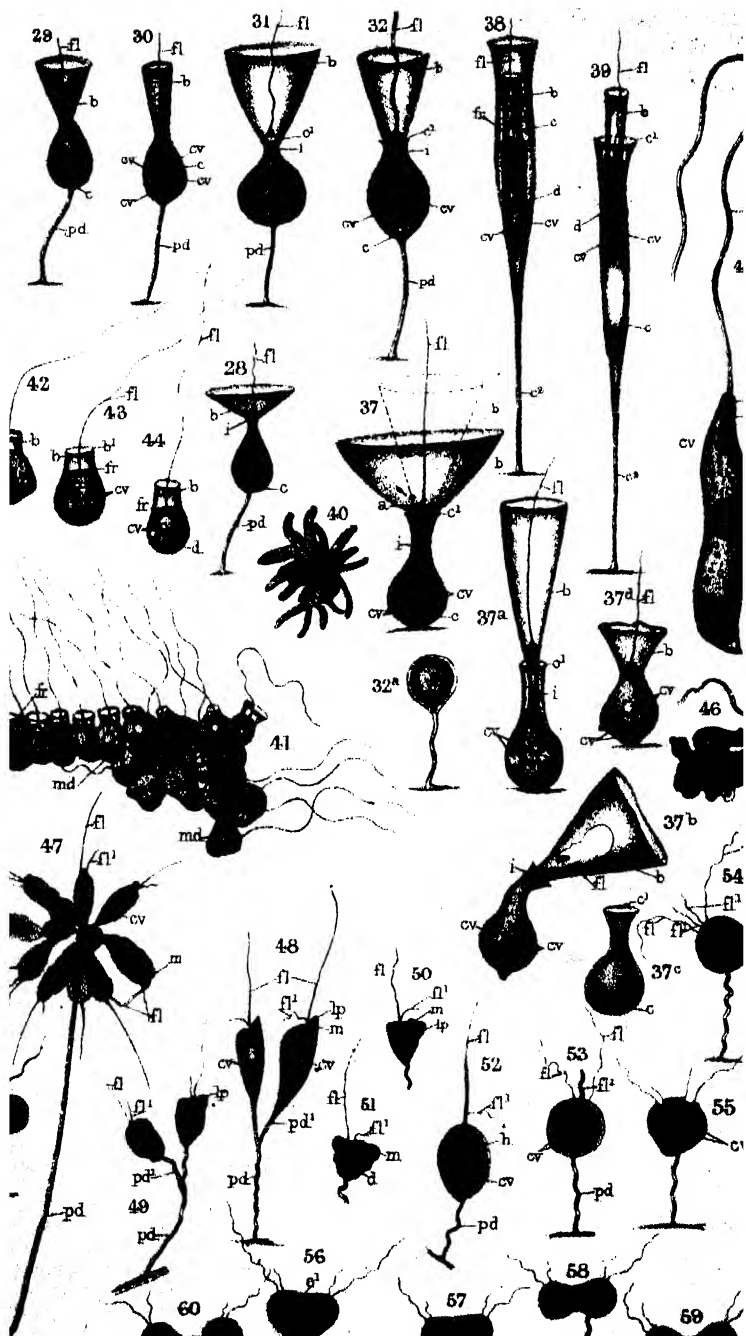
Fig. 1











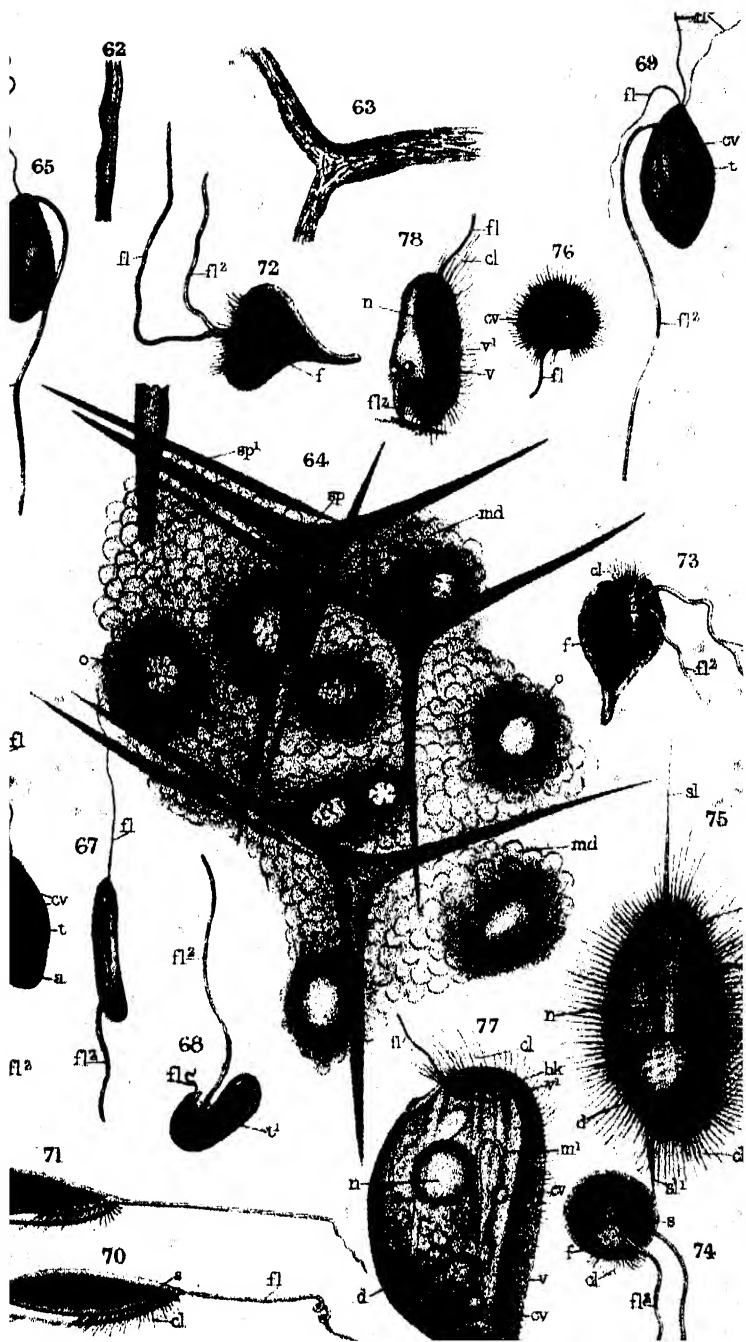


Fig 1

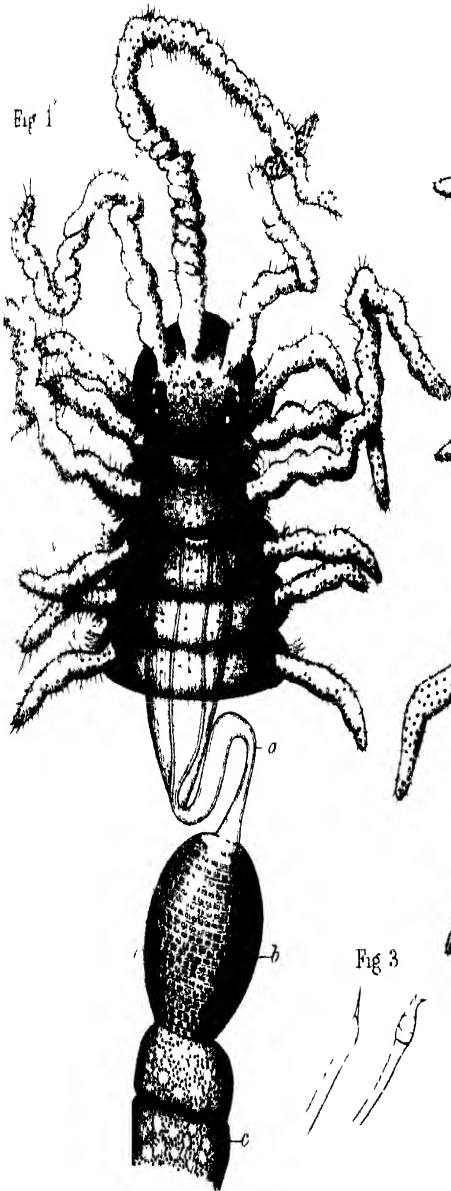


Fig 2

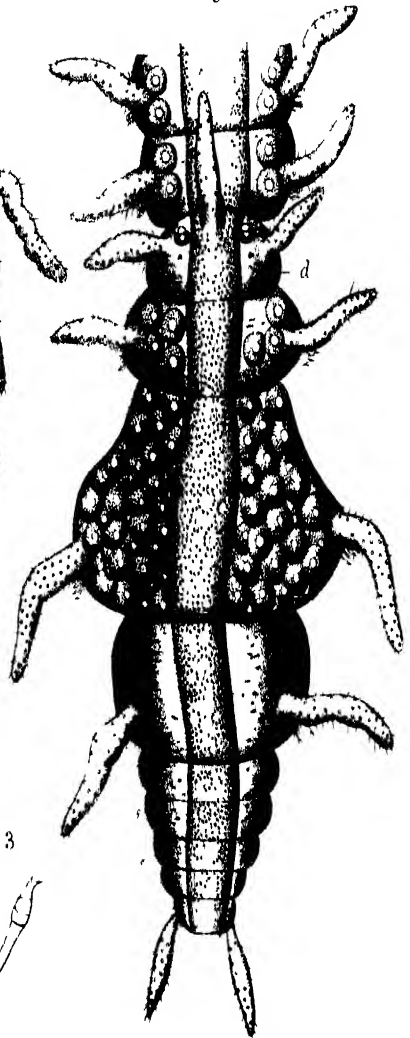
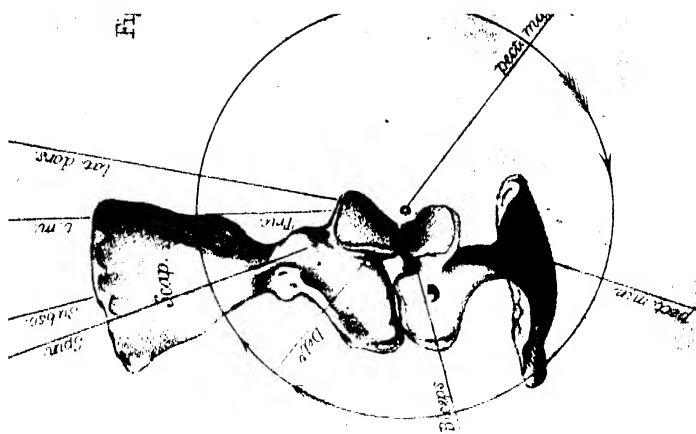
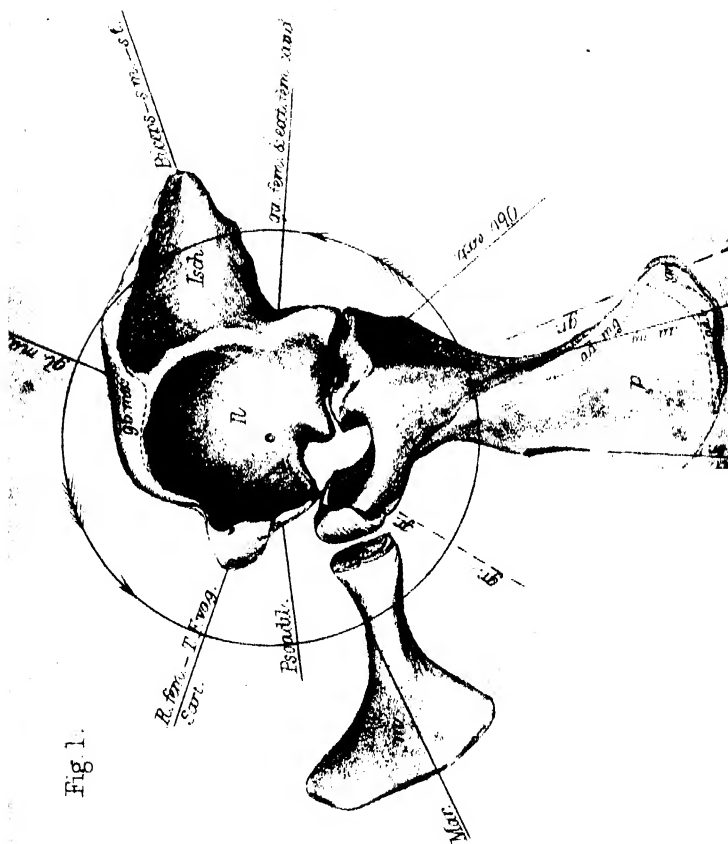


Fig 3







zone

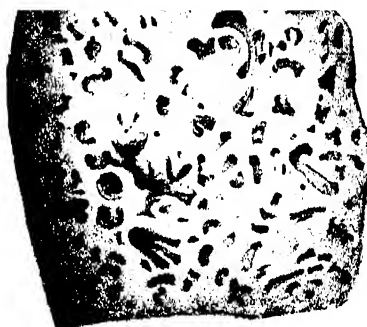


Fig. 3.



Fig. 4.

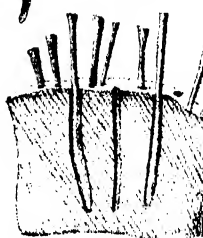


Fig. 7.

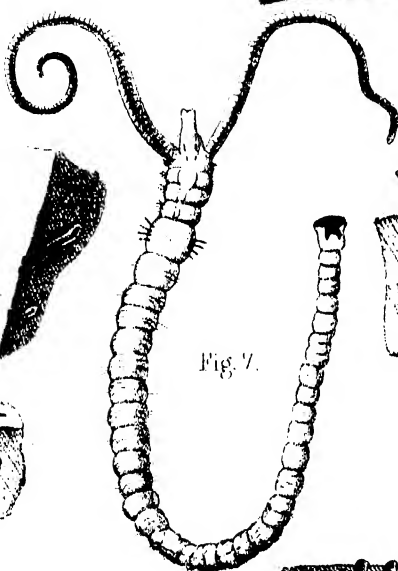
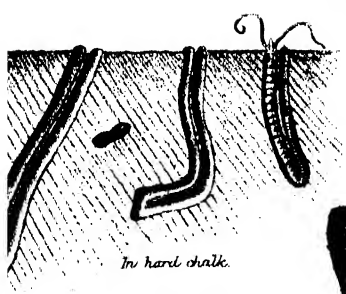
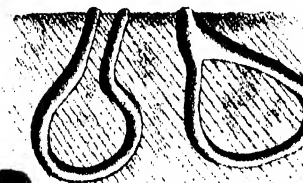


Fig. 6.



In hard chalk.



In soft chalk.



Fig. 8.



Fig. 9.



Fig.



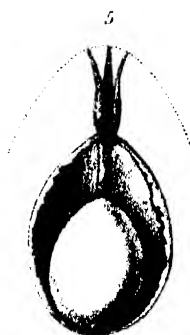
A



B

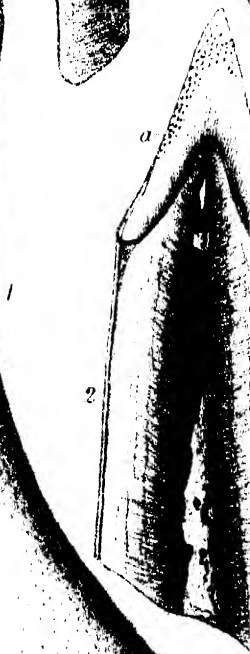
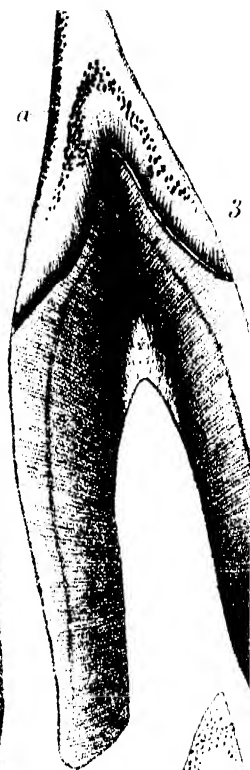
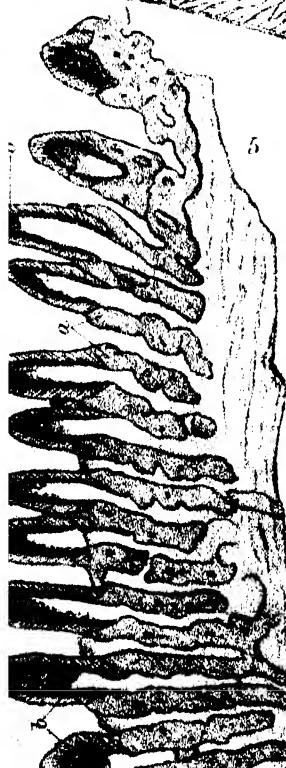
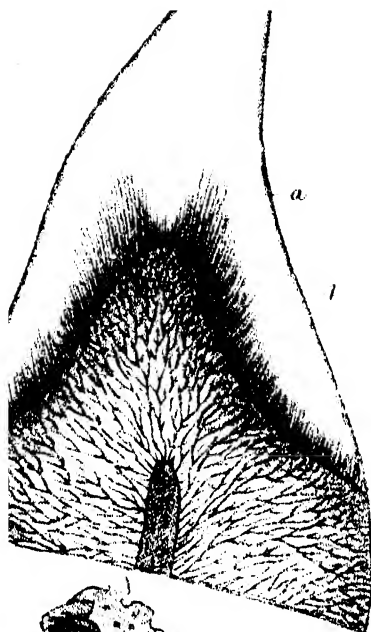


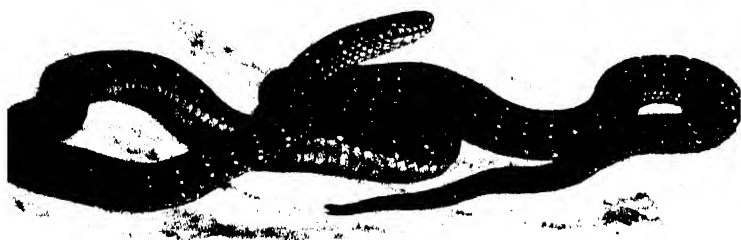
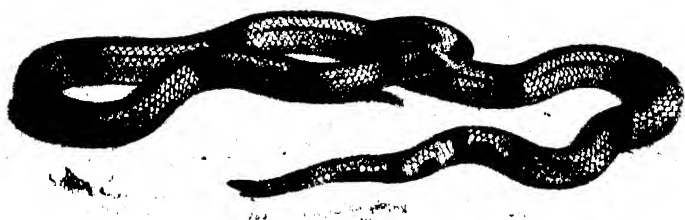
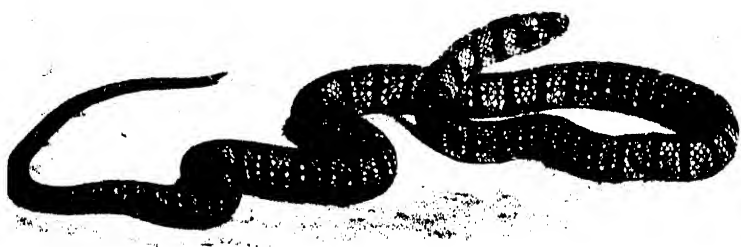
A. Gobius doriae. B. Eleotris dasyrhynchus



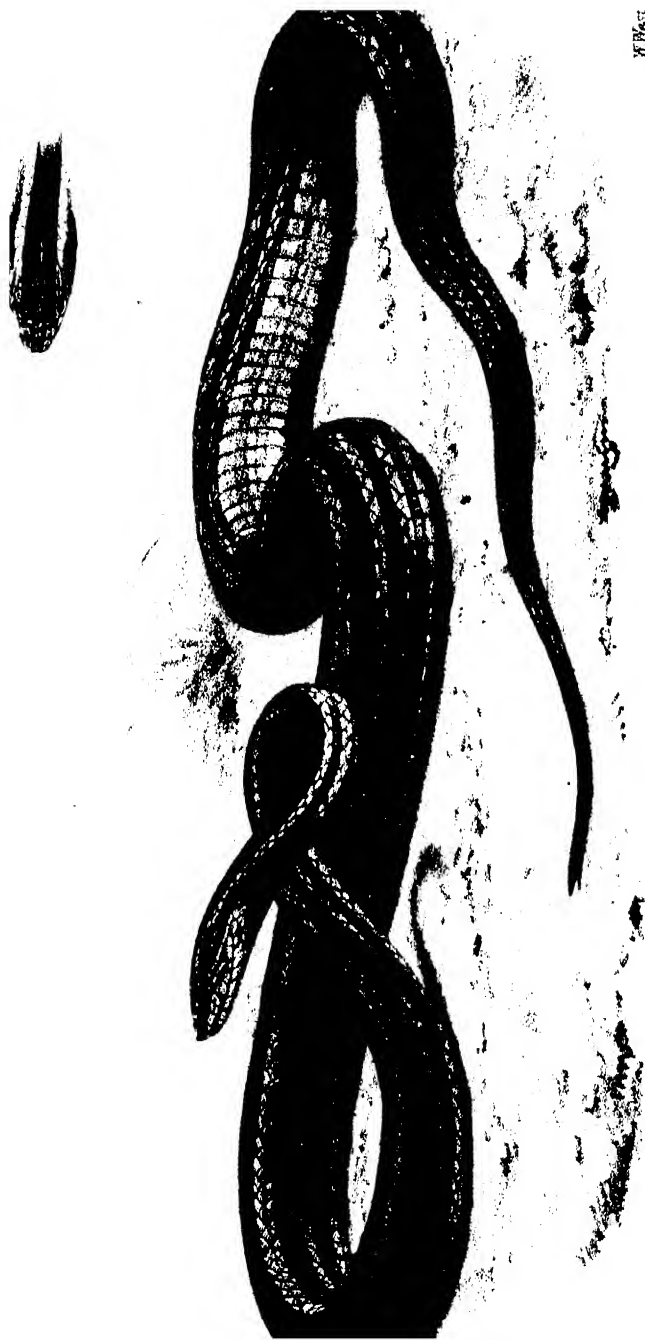








Mimophis madagascanensis





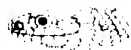
A



B



C



D



E



F



G



H



I



K



